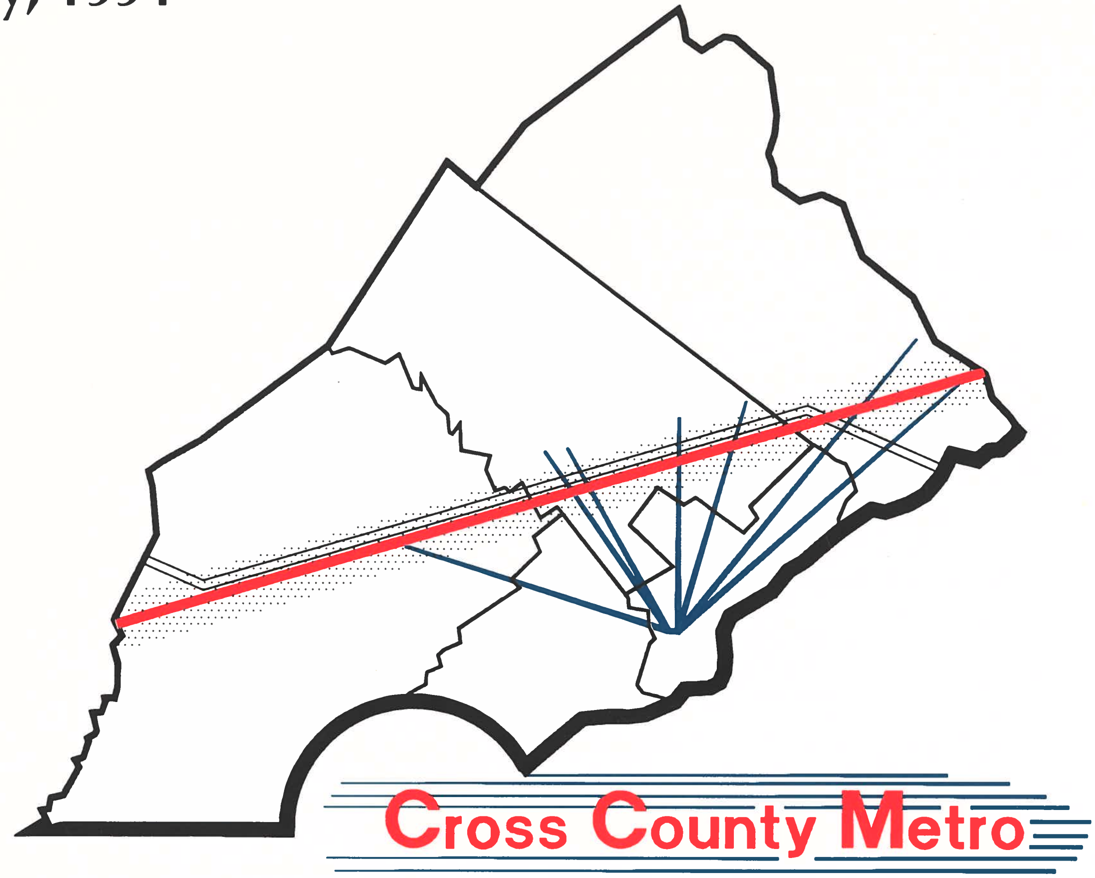
CROSS COUNTY METRO FEASIBILITY ASSESSMENT

Final Report
May, 1994



Prepared for:
Southeastern Pennsylvania
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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report summarizes the results of the Cross County Metro Feasibility Assessment conducted on behalf of the Southeastern Pennsylvania Transportation Authority (SEPTA) by a consulting engineering team led by Urban Engineers, Inc. (UEI). The study analyzed the feasibility of developing public transportation service in an existing Conrail freight line corridor extending from Parkesburg in Chester County, PA through Montgomery and Bucks Counties to Trenton in Mercer County, NJ, a distance of 67 miles.

The study consisted of five steps:

- Assessment of present and future corridor conditions
- Select modal alternatives and station locations
- Develop operating and physical characteristics of each modal alternative
- Analyze potential ridership
- Evaluate alternatives against FTA guidelines for ridership, costs, revenues and other impacts and benefits

An initial list of eighteen possible modal alternatives based on different propulsion and guideway characteristics was developed. The primary purpose of defining the alternatives to be studied was not to focus on the exact technologies that would be used, but to cover a representative number of alternatives that could provide a reasonably wide spectrum of service and cost characteristics suitable for testing future ridership and feasibility scenarios. Being representative, the particular modal technologies considered do not represent a final selection. Through a two-step process the Technical Advisory Committee chose three Build alternatives and one No-build alternative for further study.

The alternatives are:

- Regional Rail - electrically powered commuter rail operation providing service between Downingtown and Trenton with connection to existing AMTRAK and SEPTA rail service at the two termini and, additionally, with New Jersey Transit at Trenton. The line would be configured as a single track with passing sidings. This was subsequently revised to service between Glenloch and Trenton.

- Light Rail - electrically powered light rail operation providing service between Glenloch and Morrisville through Norristown. The line would be configured as a single track with passing sidings. It would connect to existing SEPTA regional rail service and with the Norristown High Speed Line.

- Busway - dedicated two lane busway between Glenloch and Morrisville using a combination of trunk line express serve and local service over portions of the line to service major local traffic generators.

- Improved Bus - no-build alternative utilizing increased bus service through Transportation Systems Management improvements at key areas such as toll plazas, intersections and interchange ramps.

Travel demand was estimated based on present (1990 Census base) and future (2010 DVRPC forecasts) population and employment data. Since land use along the corridor is not currently oriented to public transit service, an Enhanced Land Use scenario was also developed to test the ridership demand based on a more concentrated development pattern that would be expected to occur due to the presence of a major public transit facility.

To address costs of each alternative, a series of conditions were developed to analyze a variety of changes to present SEPTA operating procedures. These changes would affect productivity and minimize possible duplication of some services for the proposed line. Two cost bases were used:

- Full Cost assumes a full allocation of costs including headquarters costs and retention of existing SEPTA operating procedures and equipment configurations.
- Base Cost does not include any increase in headquarters costs and assumes certain improvements in equipment configuration and staffing of trains.

An enhanced scenario of more transit friendly development patterns was also studied which included an Enhanced Cost base assuming further cost saving improvements in equipment and staffing.

MAJOR CONCLUSIONS

The frame work for feasibility assessment was developed based on Federal Transit Administration procedures for projects which might receive federal funding. The evaluation measures used were:

- Cost Effectiveness
- Financial Feasibility
- Equity
- Environmental/Community Impacts

These measures were assessed using standard indices outlined by the FTA. The following exhibits summarizes key data for each alternative based on the two cost assumptions used and the two land use scenarios which were developed.

SUMMARY OF BASE LAND USE RIDERSHIP AND COSTS

	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVE BUS
Route Length (mi)	48	47.6	46.4	63.6
No. of Stations	17	18	16	N/A
Daily Trips	9609	9106	5587	1324
Annual Revenue*	$10,262	$4,125	$2,279	$540
FULL COST ASSUMPTIONS				
Annual Operating*	$26,468	$9,700	$6,378	$5,679
Farebox Recovery	39%	43%	36%	10%
Total Capital*	$393,561	$371,510	$476,320	$12,849
Annualized Capital*	$32,239	$30,345	$41,118	$1,473
Cost Index**	$20.74	$14.09	$31.55	N/A
BASE COST ASSUMPTIONS				
Annual Operating*	$20,897	$7,093	$5,725	$5,116
Farebox Recovery	49%	58%	40%	11%
Total Capital*	$393,561	$350,338	$476,320	$12,849
Annualized Capital*	$32,239	$28,523	$41,118	$1,473
Cost Index**	$18.73	$12.43	$31.48	N/A

*** (1,000's)**
**** Dollars per Rider**

Regional Rail Route Length: Glenloch to Trenton
Light Rail Route Length: Glenloch to Morrisville via Norristown
Busway Route Length: Glenloch to Morrisville
Improved Bus Route Length: Via US 202, PA Turnpike, & local roads.

Urban Engineers, Inc. 1993

SUMMARY OF ENHANCED LAND USE RIDERSHIP AND COSTS

	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVE BUS
Route Length (mi)	48	47.6	46.4	63.6
No. of Stations	17	18	16	N/A
Daily Trips	11,435	10,836	6,649	1,576
Annual Revenue*	$12,212	$4,909	$2,713	$643
BASE COST ASSUMPTIONS				
Annual Operating*	$20,897	$7,093	$5,725	$5,116
Farebox Recovery	58%	69%	47%	13%
Total Capital*	$393,561	$350,338	$476,320	$12,849
Annualized Capital*	$32,239	$28,523	$41,118	$1,473
Cost Index**	$15.74	$10.45	$26.45	N/A
ENHANCED COST ASSUMPTIONS				
Annual Operating*	$14,358	$6,727	$5,557	$4,957
Farebox Recovery	85%	73%	49%	13%
Total Capital*	$362,116	$350,338	$476,320	$12,849
Annualized Capital*	$29,518	$28,523	$41,118	$1,473
Cost Index**	$12.66	$10.37	$26.44	N/A

*** (1,000's)**
**** Dollars/rider**

Regional Rail Route Length: Glenloch to Trenton
Light Rail Route Length: Glenloch to Morrisville via Norristown
Busway Route Length: Glenloch to Morrisville
Improved Bus Route Length: Via US 202, PA Turnpike, & local roads.

Urban Engineers, Inc. 1993

Regional Rail alternatives are predicted to attract slightly higher ridership than Light Rail alternatives. Both rail modes would attract significantly higher ridership than the Busway and Improved Bus alternatives. When viewed from a cost effectiveness standpoint, the Light Rail ranks higher due to its lower operating cost. The busway ranks low due to its high capital costs. Cost condition changes improve cost effectiveness for the Build alternatives. Also, the Enhanced Land Use scenario brings cost effectiveness measures well within the range of other major transit projects currently in the planning and design stages in other jurisdictions. Farebox recovery ratios for the rail alternatives are forecast within the range of existing SEPTA services. Capital funding for a Cross County Metro service is available from Federal programs. State and local governments would need to fund a minimum of 20% of the capital costs.

Potential benefits from the implementation of the Cross County Metro include:

- Improvement of air quality through reduced fuel consumption
- Reduction in highway congestion resulting in further reduction in fuel consumption and improved trip times
- Savings in energy consumption would be 0.6 million kWH annually for the Light Rail alternative
- Mobility would be improved through provision of additional transportation options in the corridor.

The study was developed using what are believed to be generally conservative assumptions. A more detailed study of the corridor could be expected to yield further improvement in the various performance ratios. The following issues should be included in any further assessment:

- Review ridership from outside corridor study area
- Review potential for increased ridership resulting from requirements of the Clean Air Act's Employer Trip Reduction Program

- Review necessity for two car trains for Regional Rail alternatives as presently required by AMTRAK
- Review adjustment in staffing levels in conjunction with changes in fare collection methods.
- Review travel times used in demand models with respect to delays at parallel Turnpike toll locations.
- Review model parameters related to off peak/peak trips.
- Focus on ridership changes due to different fare structures by mode.

In conclusion, a policy decision is required to further development of the Cross County Metro corridor through the next step, the Federal Transit Administration's Major Investment Analysis process. This study provides the background information and support for such a decision.

CHAPTER 1

INTRODUCTION

INTRODUCTION

The Cross County Metro Feasibility Assessment represents the initial step in the possible implementation of a new inter county suburban transit service through a corridor extending across the northern and western suburbs of Philadelphia.

BACKGROUND

The corridor, which is paralleled by portions of US Routes 30 and 202 and the Pennsylvania Turnpike, has been the focus of substantial growth in population and employment in recent decades. This growth has led to severe traffic congestion in the corridor. The corridor is also paralleled by an existing rail freight line which has excess capacity and is available for development of a public transportation service. Such a service would be circumferential in nature, providing a direct route between suburbs while offering the capability of providing connections with existing radial rail and bus routes providing service to central Philadelphia. The service would also serve as a focal point for future growth in the corridor, encouraging patterns of development that would rely less on highway access and that could be better served by public transportation.

Because the availability of the rail line for public transportation provides an opportunity to serve the growing demand for transportation between suburban areas while helping to relieve suburban traffic congestion, the Southeastern Pennsylvania Transportation Authority undertook a feasibility study to assess whether an inter suburban transportation service would attract sufficient riders to warrant further detailed study.

PURPOSE

The purpose of the Cross County Metro Feasibility Study was to assess, at a preliminary level, whether performance of a public transportation service, in terms of its ability to attract ridership and with respect to its operating and maintenance costs, would be sufficient to warrant advance of the concept to a more detailed level of analysis. The feasibility assessment represents the initial step in a Federally mandated process applied to all transportation projects that would receive federal funds for implementation. It was not the purpose of the feasibility study to determine the mode or configuration of service, but rather to test a variety of service and modal scenarios as a gage of the costs and attractiveness of a public transportation service. Where projected ridership and costs are within an accepted range of performance, the project would then become eligible for federal funds to perform a detailed Alternatives Analysis that would seek to determine a preferred mode and service.

IMPLEMENTATION

The Cross County Metro Feasibility Assessment was funded, administered, and directed by SEPTA who hired a team of consultants to perform the analysis. The study was conducted under the guidance of a Technical Advisory Committee composed of representatives of Delaware, Chester, Montgomery, and Bucks Counties, the City of Philadelphia, the Pennsylvania Department of Transportation and the Delaware Valley Regional Planning Commission. The individual members of the Technical Advisory Committee are listed in Appendix 3. During the study the consultants prepared a series of Technical Memoranda, detailing the process and findings of each step in the feasibility assessment. The Technical Memoranda were distributed to the Technical Advisory Committee which met with SEPTA and the consultants on a regular basis throughout the course of the study providing review and comment. Eleven meetings were held. Consensus of the committee was obtained for all of the major policy decisions made as the study progressed. The key policy decisions included the specific modal alternatives to be studied, the preliminary locations of stations, and the criteria for assumptions about future population and employment distribution under an enhanced land use scenario.

CHAPTER 2

CORRIDOR DEFINITION

CORRIDOR DEFINITION

The corridor considered for the Cross County Metro Feasibility Study extends from Parkesburg in Chester County to Trenton, New Jersey, a distance of 67 miles. This chapter identifies characteristics of each major segment of the corridor.

The focus of the study is Conrail's Morrisville line (formerly known as the Trenton Cutoff). It has sufficient right of way width and infrastructure elements to accommodate two (2) tracks and runs from Glenloch in Chester County to Morrisville in Bucks County. At present, Conrail has one track in operation within the right of way. The western portion of the line parallels US Routes 30 and 202; the central and eastern portions of the line parallel the Pennsylvania Turnpike. This segment is 46 miles long. The line cuts across the northern and western suburbs of Philadelphia and intersects many of SEPTA's radially oriented Regional Rail, Light Rail, and Bus routes.

At its western end, the Morrisville line connects to Amtrak's Harrisburg line which is also used by SEPTA's Regional Rail Route R5, providing service from Philadelphia to as far west as Downingtown, with some trains extending to Parkesburg. The section from Glenloch to Coatesville parallels US Route 30. There has been heavy commercial and residential development along this section of Route 30. This is a continuation of the development along US Route 202 and the Pennsylvania Turnpike further east and logically this area should be included in any new service area designed to meet the transportation needs of this corridor's development. The study area takes into account as far west as Parkesburg in order to include regional economic development centers between Downingtown and Parkesburg. Although existing rail service west of Downingtown is currently limited to three round trips per day, it is expected that development will continue to spread westward into this area in the future. In addition, connection with Amtrak services at Downingtown or Parkesburg may generate additional ridership on a Cross County Metro service. The distance from Glenloch to Parkesburg is 19.4 miles.

At its eastern end the Morrisville line connects to Amtrak's Northeast Corridor line which is also used by SEPTA's Regional Rail Route R7, providing service from Philadelphia to Trenton. The additional distance from Morrisville to Trenton is 1.6 miles. The opportunity exists for a Cross County Metro service to directly connect in Trenton with Amtrak and New Jersey Transit services. Also, Trenton is a major employment center and therefore it is logical to include Trenton in the study corridor. Trenton, as both an employment center and transfer point, may offer opportunities to generate additional ridership on a Cross County Metro service.

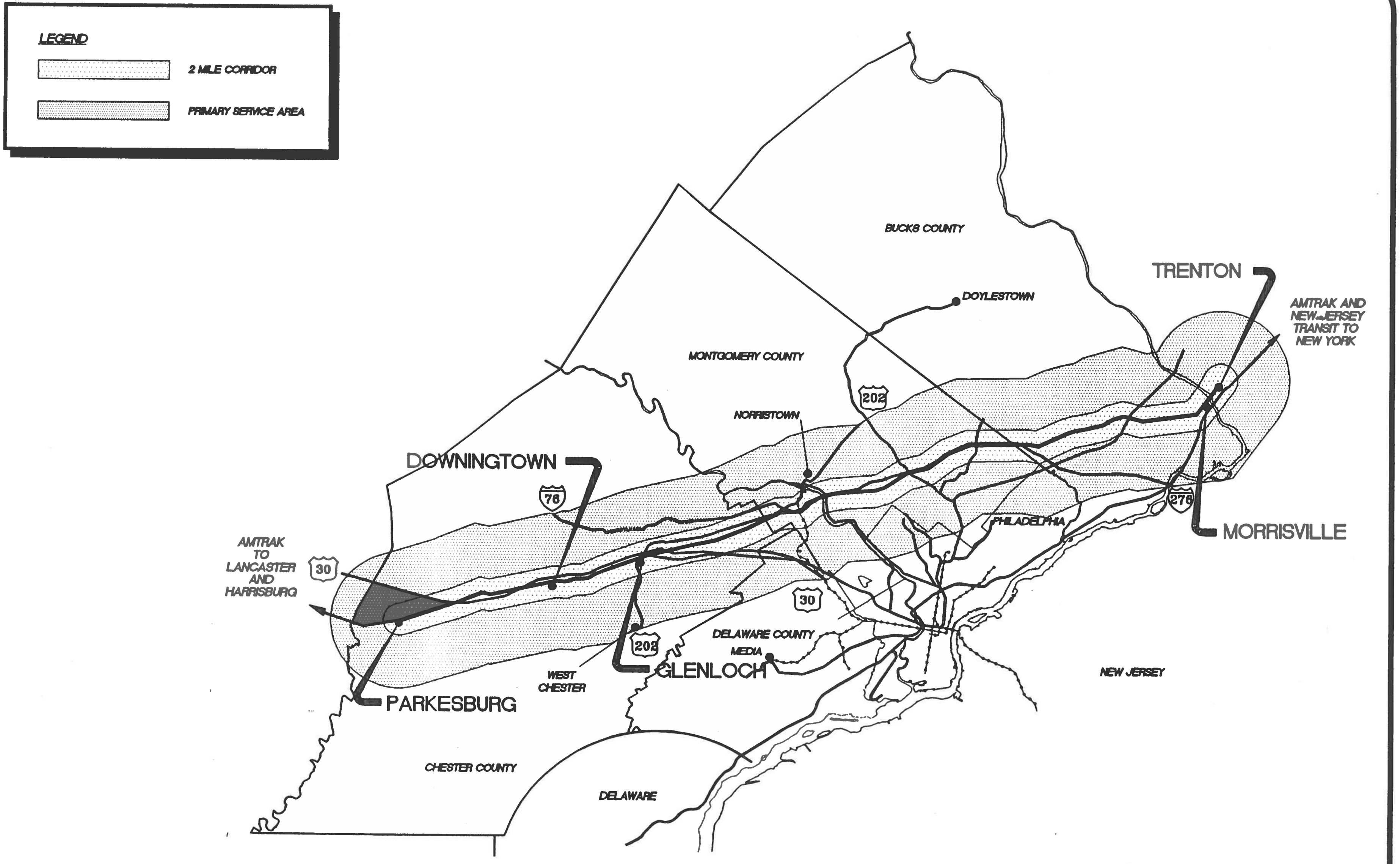
The corridor that was studied therefore extended from Parkesburg in Chester County to Trenton, New Jersey, a total of 67 miles. Although the proposed corridor overlaps with existing services at each end, it is not being suggested that duplicate or overlapping facilities would be built. Rather, the determination of ridership takes into account either a direct extension of service to the end points for modes compatible with existing regional rail operations, or convenient transfers to existing services at Glenloch and Morrisville in the case of non-compatible modes.

While the corridor, as defined, is based primarily on existing rail rights-of-way, this same corridor is also served by a combination of the Pennsylvania Turnpike, US Route 202, and US Route 30 which together form a parallel highway corridor. This parallel highway corridor will be the focal point for studying non-rail options for a Cross County Metro service.

The width of the corridor studied takes into account both land use considerations and potential ridership. The corridor analysis studied the relationship between pedestrian access and land use, which included uses generated by the introduction of the service and its stations, and land uses induced by zoning and other policies designed to enhance the utility of the service. The corridor in which land use issues were closely studied is two miles wide, extending a distance of one mile to either side of the Cross County Metro.

Because a Cross County Metro service would have the opportunity to allow transfers to and from other existing SEPTA services, especially the Regional Rail System, the potential exists for ridership on the service to be drawn from a large portion of the region including origins or destinations within the City of Philadelphia, points south of the City including Philadelphia International Airport, and points north and west of the corridor. For this reason, travel within the entire five county region was used for determining ridership on a Cross County Metro service.

Although the area of the corridor for purposes of ridership includes the entire five county region, it is expected that most of the ridership attracted to a Cross County Metro service will originate and terminate within a 10 mile wide direct access corridor extending five miles to either side of the line. The Cross County Corridor is shown in Exhibit 2-1.



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Cross County Metro

CORRIDOR MAP

EXHIBIT
2-1

CHAPTER 3

CORRIDOR CONDITIONS

CORRIDOR CONDITIONS

A key task of the Cross County Metro Corridor Study was to produce an accurate assessment of existing and future socioeconomic (S/E) conditions within the corridor. The S/E characteristics define trip generation which, in turn, is used for modal split analyses. The corridor S/E databases were also used as an initial starting point for testing the impact that alternative land use scenarios may have on corridor transit ridership.

S/E characteristics were assessed with data provided by the Delaware Valley Regional Planning Commission. This data is based on 1990 Census data and 2010 projections. The data is presented by traffic analysis zone (TAZ). The TAZ's (as opposed to municipalities) are used as the basic division for presenting the data in order to be consistent with the demand modeling process whose trip tables and modal split analysis are based on TAZ's. Typically a municipality such as a township or borough will contain one or more TAZ's within their boundaries. Appendix A of the Technical Appendix shows the TAZ's. Following is a brief description of the S/E characteristics of the two-mile wide corridor.

POPULATION

The 1990 population of the corridor in Chester, Montgomery, Bucks, and Mercer counties was about 448,000. Within Chester, Montgomery, and Bucks Counties the corridor population is fairly evenly distributed, but taking into account the counties as a whole, a disproportionately large share of the county populations are located in the corridor. The corridor represents from 6 to 8 percent of the land area of the three Pennsylvania counties but contains 21 to 37 percent of the total county populations. The corridor thus represents the most densely developed portions of these counties.

The portion of the corridor in Mercer County lies entirely within the City of Trenton. Population density of the corridor ranged from 2185 to 6615 persons per square mile. As a comparison, the population density of Philadelphia was 12,291 persons per square mile.

The average number of persons per household was 2.73 for Chester County, 2.60 for Montgomery County, 2.85 for Bucks County and 3.16 for Mercer County, averaging to 2.75 persons per household for the entire corridor. The larger household size for Mercer County reflects that the portion of the Corridor in Mercer County covers a small but densely populated area in the heart of Trenton. The average household size for the corridor excluding Mercer County is 2.72 persons. This compares with an average household size of 2.54 for the entire City of Philadelphia. The higher household size in the corridor reflects that the suburban areas are a preferred location for families raising children.

Automobile ownership within the corridor is relatively high in the three Pennsylvania counties, averaging about 1.85 automobiles per household. In Mercer County, the average is only 0.8 cars per household, reflecting that the corridor in Mercer County lies within the City of Trenton. Approximately 7.7 percent of the corridor households (including Mercer County) have no automobiles. Many of these households are within Trenton. In contrast, the average number of cars per household in the City of Philadelphia was approximately 0.9 with 38 percent of households having no automobile, reflecting a more transit dependent population.

The 2010 population for the corridor is estimated to be about 490,000, representing a 9.4% increase over 1990. Households are projected to grow to 184,500 with an average of 2.66 persons per household. Average cars per household will increase to about two. Approximately 5.8 percent of the households are projected to have no automobile. Again, many of these households are within Trenton. Population in the City of Philadelphia is projected to decrease while automobile ownership will increase slightly from 0.88 to 0.94 cars per household.

As compared to a transit oriented city such as Philadelphia, the Cross County Corridor has significantly lower population density and higher automobile ownership, which is typical of suburban areas. Since only a small percentage of the corridor households have no automobile, use of public transit is more a matter of choice than necessity, indicating that a high level of service will be required to attract riders. At the same time the corridor represents a densely developed portion of the suburban counties, and is subject to significant traffic congestion, indicating that the need for a transportation alternative is there. However, the population in the corridor as a percentage of total county population is projected to decrease by 2010 indicating a continuing trend of growth away from the corridor into the more rural areas of the counties. A public transportation service in the corridor, with its ability to attract more dense development, has the potential to reverse that trend. Exhibit 3-1 presents population and household characteristics for the corridor by county.

EMPLOYMENT

The 1990 employment estimate for the Cross-County Corridor is about 348,000. Nearly 40 percent of the corridor's employment is within Montgomery County, 31% is within Chester County, 18% is in Bucks County, and 11% is in Mercer County. Over 46 percent of the corridor's total employment is in the office/service/government sectors, and 17 percent is in the retail sector.

The 2010 employment estimate for the corridor is about 414,000, representing a 19% growth in total employment (over 1990 totals). Approximately 38 percent of the corridor's employment is within Montgomery County, 35% is within Chester County, 17% is in Bucks County, and 10% is in Mercer County. Exhibit 3-2 summarizes employment characteristics within the corridor, by county.

Exhibit 3-1

DEMOGRAPHIC CHARACTERISTICS WITHIN THE CROSS COUNTY CORRIDOR

	Chester	Mont-gomery	Bucks	Mercer	Total
1990 Pop. (Entire County)	376,395	678,106	541,172	325,824	1,921,497
2010 Pop. (Entire County)	460,190	744,890	651,284	370,891	2,227,255
1990 Pop.	137,713	141,432	142,198	26,459	447,802
2010 Pop.	163,361	140,616	158,956	27,069	490,002
1990 % County Pop. in Corridor	36.6%	20.9%	26.3%	8.1%	23.3%
2010 % County Pop. in Corridor	35.5%	18.9%	24.4%	7.3%	22.0%
1990 Hhld.	50,451	54,372	49,827	8,360	163,010
2010 Hhld.	61,992	56,730	58,172	7,605	184,499
1990 % w/ no Autos	5.9%	6.2%	5.0%	44.4%	7.7%
2010 % w/ no Autos	4.2%	4.9%	3.6%	42.1%	5.8%

Note: Demographic characteristics presented in table are only for those portions of each county that are within the defined corridor except where noted.

Urban Engineers, Inc., 1993

Exhibit 3-2

EMPLOYMENT CHARACTERISTICS WITHIN THE CROSS COUNTY CORRIDOR

	Chester	**Mont-gomery**	**Bucks**	**Mercer**	**Total**
1990 Empl. (Entire County)	198,958	457,449	245,340	220,596	1,122,343
2010 Empl. (Entire County)	251,295	527,556	285,573	266,583	1,331,007
1990 Empl.	108,915	137,901	61,274	39,721	347,811
1990 % Empl. in Corridor	55%	30%	25%	18%	31%
% Off./Gov't.	42.4%	39.8%	41.3%	80.0%	45.5%
% Retail	15.7%	14.0%	30.2%	7.4%	16.6%
% Other	41.9%	46.2%	28.5%	12.6%	37.9%
2010 Empl.	144,170	158,029	70,278	41,480	413,957
2010 % Empl. in Corridor	57%	30%	25%	16%	31%
% Off./Gov't.	44.2%	42.6%	41.5%	80.6%	46.8%
% Retail	15.9%	14.3%	32.3%	7.2%	17.2%
% Other	39.9%	43.1%	26.2%	12.2%	36.0%

Note: Employment characteristics presented in table are only for those portions of each county that are within the defined corridor except as noted.

Urban Engineers, Inc., 1993

Employment characteristics and trends within the corridor are similar to population, with the corridor employment representing a disproportionate share of the total county employment, ranging from 25 to 57 percent of total county employment for the three Pennsylvania Counties. Excluding Trenton, employment density ranges from 2067 to 3951 persons per square mile. In Trenton it is 10,370 persons per square mile reflecting the traditional urban character of Trenton and the location of the state government. While employment in the corridor will grow considerably by 2010 (up to 32 percent in Chester County), the percent of total county employment in the corridor will decrease slightly in all but Chester County, reflecting the continuing trend of dispersed growth. Congestion in the corridor can be expected to increase as total employment grows, and the congestion will likely spread to areas outside of the corridor. A public transportation service in the corridor will help to decrease existing and expected congestion in the corridor. It will also serve as a magnet for employment growth and thus offer the potential of preventing or reducing increases in congestion outside of the corridor.

Appendix B of the separate Technical Appendix document contains TAZ demographic data for 1990 and 2010, for all TAZ's within the two-mile corridor. Appendix C contains TAZ employment data for 1990 and 2010, for all TAZ's within the two mile corridor.

HIGHWAY NETWORK

When forecasting transit ridership, it is important to recognize alternative mode options that exist. Within the Cross County Metro corridor, there are portions of four principal arterials that parallel the proposed service area:

- US Route 30 (Lincoln Highway)
- US Route 202
- PA Turnpike
- US Route 1

In addition, there are dozens of other arterial and major collector facilities that intersect the corridor. These roadways provide the opportunity for access to the Cross County Metro via automobile or bus transfer. They are logical locations for development of stations. The principal intersecting highways are listed in Exhibit 3-3.

Exhibit 3-3

PRINCIPAL INTERSECTING HIGHWAYS IN THE CROSS COUNTY CORRIDOR

PA Route 340
Marshallton - Thorndale Road
PA Route 113
PA Route 322
PA Route 100
PA 352 Sproul Road
PA Route 252
Phoenixville Pike
Route 422 Expwy
I-76 Schuylkill Expwy
Gulph Road
Henderson Road
PA Route 23 River Road
Conshohocken Pike
Ridge Pike
I-476
US Route 422 (Germantown Pike)
Butler Pike
PA Route 73
Bethlehem Pike
US Route 309
PA Route 152
PA Route 63
PA Route 611
PA Route 263
Byberry Road
County Line Road
PA Route 232
PA Route 413
PA Route 432
I-95
Oxford Valley Road
US Route 13
Pennsylvania Avenue

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TRANSIT NETWORK

Rail Service

Rail service within the corridor is presently provided by six of SEPTA's regional rail lines, SEPTA's Norristown High Speed Line, NJ Transit and Amtrak. Schedules were collected from each operator to determine the level of train service presently provided within the corridor. Exhibit 3-4 gives a listing of intersecting rail services.

There are 24 rail stations within the corridor that are served by SEPTA. The Trenton station is also served by NJ Transit and Amtrak. Select rail stations on SEPTA's R5 line are also used by Amtrak's Keystone service.

Bus Service

Bus service within the Cross County Metro Corridor is provided by SEPTA, as well as by private operators. There are 24 SEPTA bus routes that presently provide service within the corridor. Many of these routes feed into SEPTA regional rail stations. Exhibit 3-5 shows a listing of bus routes which enter into or cross the Study Corridor.

Four private operators also provide service within the corridor. Greyhound provides service to the corridor, with scheduled stops at King of Prussia, Exton and Willow Grove. Krapf's Transit also provides service from Coatesville to West Chester. Scheduled stops within the corridor by this operator are at Downingtown and the Exton Mall. Service is provided at 60 minute headways. Martz Trailways provides service from Scranton to Philadelphia, with scheduled stops at King of Prussia Mall. Finally, Bieber Tourways provides bus service from Reading to Philadelphia via Allentown. This service crosses the corridor at Upper Dublin.

Exhibit 3-4

RAIL LINE SERVICE CHARACTERISTICS WITHIN THE CROSS COUNTY CORRIDOR

Operator	Train #	Service Line	Stations in Corridor	Daily NB/ EB Trains	Daily SB/ WB Trains	Pk. Period Headway (min)	Base Headway (min)
SEPTA	R2	Warminster to Central City	Hatboro Fulmor Willow Grove	22	22	30	60
	R3	West Trenton to Center City	Woodbourne	24	23	20	60
	R5	Doylestown to Center City	Ambler Ft. Washington Fellwick Oreland	37	39	15	30
	R5	Parkesburg to Center City	Downington Whitford Exton Malvern Paoli Daylesford Berwyn Devon Strafford	14	13	30	120
	R6	Norristown to Center City	Norristown T.Ctr. Mogees	24	24	20	60
	R7	Trenton to Center City	Trenton	25	25	20	60
	100	Norristown to 69th St. Term.	Norristown T.Ctr. Bridgeport King Manor Hughes Park Gulph Mills	63	64	15	20
N.J. TRANSIT	N.E. Corr. Line	Trenton to New York	Trenton	44	48	15	30
AMTRAK	N.E. Corr. Lines	Boston to Wash. D.C.	Trenton	30	29	n/a	n/a
	Keystone Line	Harrisburg to New York	Downingtown Whitford Exton Malvern Paoli	12	11	n/a	n/a

NOTES:
(1) SEPTA Service Characteristics based on 1991 Operating Schedules.
(2) NJ Transit & Amtrak Service Characteristics based on 1992 Operating Schedules.

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Exhibit 3-5

SEPTA BUS ROUTE SERVICE CHARACTERISTICS WITHIN THE CROSS COUNTY CORRIDOR

County	Rte #	Route Name	Pk Period Headway (min)	Base Headway (min)
Chester County Routes	92	King of Prussia to West Chester	60	60
	206	Great Valley to Paoli Station	30	n/a
Montgomery County Routes	L	Olney Terminal to Plymouth Meeting Mall	15	20
	4	Olney Terminal to Ft. Washington	180	n/a
	22	Olney Terminal to Warminster	20	30
	27	Plymouth Meeting Mall to Center City	30	30
	55	Olney Terminal to Willow Grove	15	20
	91	Norristown to Eagleville	60	n/a
	93	Norristown to Pottstown	60	60
	94	Chestnut Hill to Montgomery Mall	60	60
	95	Plymouth Meeting Mall to King of Prussia	60	60
	96	Norristown to Telford	60	60
	97	Penn Square to Spring Mill	60	60
	98	Oaks/Audubon to Plymouth Meeting Mall	60	60
	99	Norristown to Royersford	30	30
	201	Ft. Washington Office Center to Ft. Washington	30	60
	205	King of Prussia to Wayne Station *	60	60
	210	Horsham Business Center to Willow Grove	60	n/a
Bucks County Routes	14	Frankford Terminal to Oxford Valley Mall	5	10
	58	Frankford Terminal to Neshaminy Mall	30	30
	127	Trenton to Oxford Valley Mall	60	60
	128	Bristol to Oxford Valley Mall	60	60
	129	Torresdale to Oxford Valley Mall	60	60
	130	Oxford Valley Mall to Neshaminy Mall	60	60

NOTES:
(1) Service Characteristics based on 1992 Operating Schedules.
* Saturday Only

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Commuter Parking Operations

SEPTA provided parking supply and utilization data for SEPTA rail stations within the corridor. In addition, the park and ride lots within the corridor that are served by SEPTA express bus service were identified.

Paratransit

Paratransit within the region is provided by a number of operators, including SEPTA and various county services as follows:

Montgomery County: Paratransit in Montgomery County is provided by Suburban Transit Network, Inc. which is an association of private carriers in the county. The association administers and coordinates the program, with the actual services provided by its members.

Bucks County: Paratransit in Bucks County is provided by Bucks County Transport, Inc. which provides service directly and also subcontracts some services to other carriers, primarily taxi companies.

Mercer County: Paratransit services for persons with disabilities is provided by New Jersey Transit which provides access links to its regular route system and by TRADE which provides an independent door to door service.

Chester County: Paratransit in Chester County is administered and coordinated by the Chester County Department of Aging Services. The service is presently contracted to Krapf Transit. Krapf sub-contracts services in some areas to local cab companies.

Ridesharing

The DVRPC provides a ridesharing coordination service for the region. This will be expanded as part of the Employer Trip Reduction Program.

LAND USE

Area of Study

The study area within which land use issues were studied has previously been defined as that area within one mile on either side of Conrail's Morrisville line. In order to utilize information on land use which relates as directly as possible to the ridership forecasting task, land use data for all Delaware Valley Regional Planning Commission (DVRPC) traffic zones which fall either in whole or in part within one mile of the corridor was compiled. Typically, municipal boundaries corresponded with traffic zone boundaries except that in some cases more than one traffic zone occurred within a municipality.

Data Sources

There is no single source of data for existing or future land use information. A combination of several types of data were utilized to compile both existing and future land use information for the corridor. These sources included:

- County and municipal land use maps
- Zoning maps
- Aerial photography
- Field reconnaissance
- Comprehensive plans

Each of the three counties is different in terms of the data which their planning commissions compile and the frequency with which they update that information. Data available at the municipal level also varies. Some townships have full time planning staffs and have recently compiled information on existing and future land use and zoning. Other townships only have outdated or incomplete information available.

In Bucks County, existing land use information was compiled from the Bucks County Planning Commission's Land Use Report for Central and Lower Bucks County dated 1980 and updated where more up-to-date information was available from individual municipalities. The County is in the process of updating its Comprehensive Plan. Until that is available the only source of future land use information is a 1977 plan and local township comprehensive plans and zoning maps.

In Montgomery County, no information was available at the overall county level. Therefore, all existing and future land use information was compiled from data available at the township level.

In Chester County, land use information was compiled from the Chester County Planning Commission Land Use Plan (Element Number 5) dated 1987. Information for East Goshen Township was updated utilizing that township's Comprehensive Plan dated 1990. Changes for other areas were determined by interviewing staff members at the County Planning Commission.

Existing land use information for Trenton was compiled from the City's land use map (last updated in 1992) and future land use was compiled from the 1989 Zoning Map.

Land Use Classification

Land use was classified into six basic categories for the purposes of this study. The categories utilized were as follows:

- Residential - no differentiation was made between single family and multi-family residential areas, since the DVRPC traffic model does not distinguish between different residential types for trip generation rates

- Retail commercial - major shopping centers and downtown commercial areas

- Office - includes finance, insurance, real estate, service and government office uses*

- Protected open space - this is open space not available for development and includes parks and recreation, wetlands and protected farmlands (where these could be identified)

- Industrial - includes mining, manufacturing, transportation and wholesale uses*

- Vacant land - includes unutilized land and farmland which is not protected from development

* In many instances office and light industrial uses were combined as one use on the available land use maps. In this case land area was divided equally between office and industrial classifications unless there was data available to suggest otherwise.

Mapping

Land was mapped at a scale of one inch to one mile for all zones which fall within one mile either side of the corridor. The land use maps illustrate:

- The six land use types

- The traffic zone boundaries and identification numbers
- Municipal and county boundaries
- Major place names
- Principal roads
- Major traffic generators (such as regional malls, amusement parks, sports facilities, etc.)

Exhibit 3-6 tabulates the estimated percentage of each land use by county for the existing and future condition. Exhibits 3-7 and 3-8 show the land use characteristics for 1990 and 2010 respectively.

The general character of the corridor is different in each of the counties.

Chester County

In the western portion of Chester County, the right of way links a series of older industrial towns, such as Parkesburg, Coatesville and Downington. These towns have lost industrial jobs and have suffered economic decline. Their commercial cores are underutilized and the housing stock, which consists of late nineteenth and early twentieth century row homes and single homes on small lots, is in need of repair. Between these older urban cores, new suburban development is taking place at a rapid pace, but this area is the least developed area along the entire study corridor. By the year 2010 a significant growth in housing and commercial use is projected to take place, at densities similar to the densities which are being developed today. The potential exists for the older urban cores to be rehabilitated but there is no policy in place to encourage such redevelopment. However, if urban revitalization were to occur it would create communities at densities highly suitable for transit usage. A Cross County Metro service could help stimulate redevelopment of older communities.

Further east in Chester County, the corridor is more fully developed. To the south of

Exhibit 3-6

EXISTING AND PROPOSED LAND USE PERCENTAGE OF TOTAL AREA

	Chester	Mont-gomery	Bucks	Mercer	Total
1990					
VACANT LAND	45%	12%	22%	0%	22%
OPEN SPACE	2%	12%	5%	2%	7%
RESIDENTIAL	29%	47%	47%	38%	43%
OFFICE	9%	11%	3%	15%	8%
INDUSTRIAL	8%	12%	16%	40%	14%
RETAIL	7%	6%	7%	5%	6%
2010					
VACANT LAND	32%	5%	13%	0%	12%
OPEN SPACE	3%	12%	5%	5%	8%
RESIDENTIAL	38%	52%	50%	50%	47%
OFFICE	10%	16%	8%	20%	11%
INDUSTRIAL	9%	11%	13%	15%	12%
RETAIL	8%	8%	8%	10%	10%

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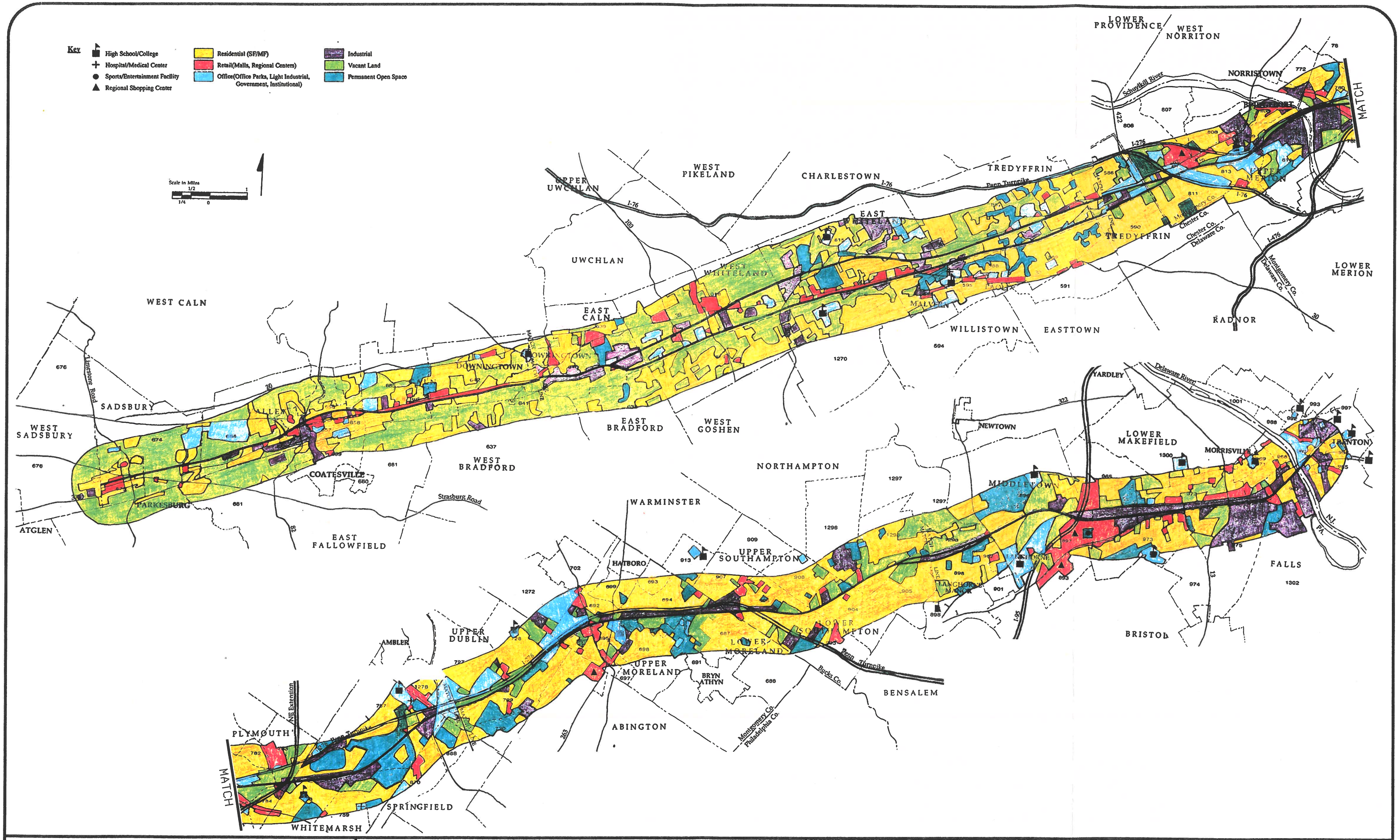

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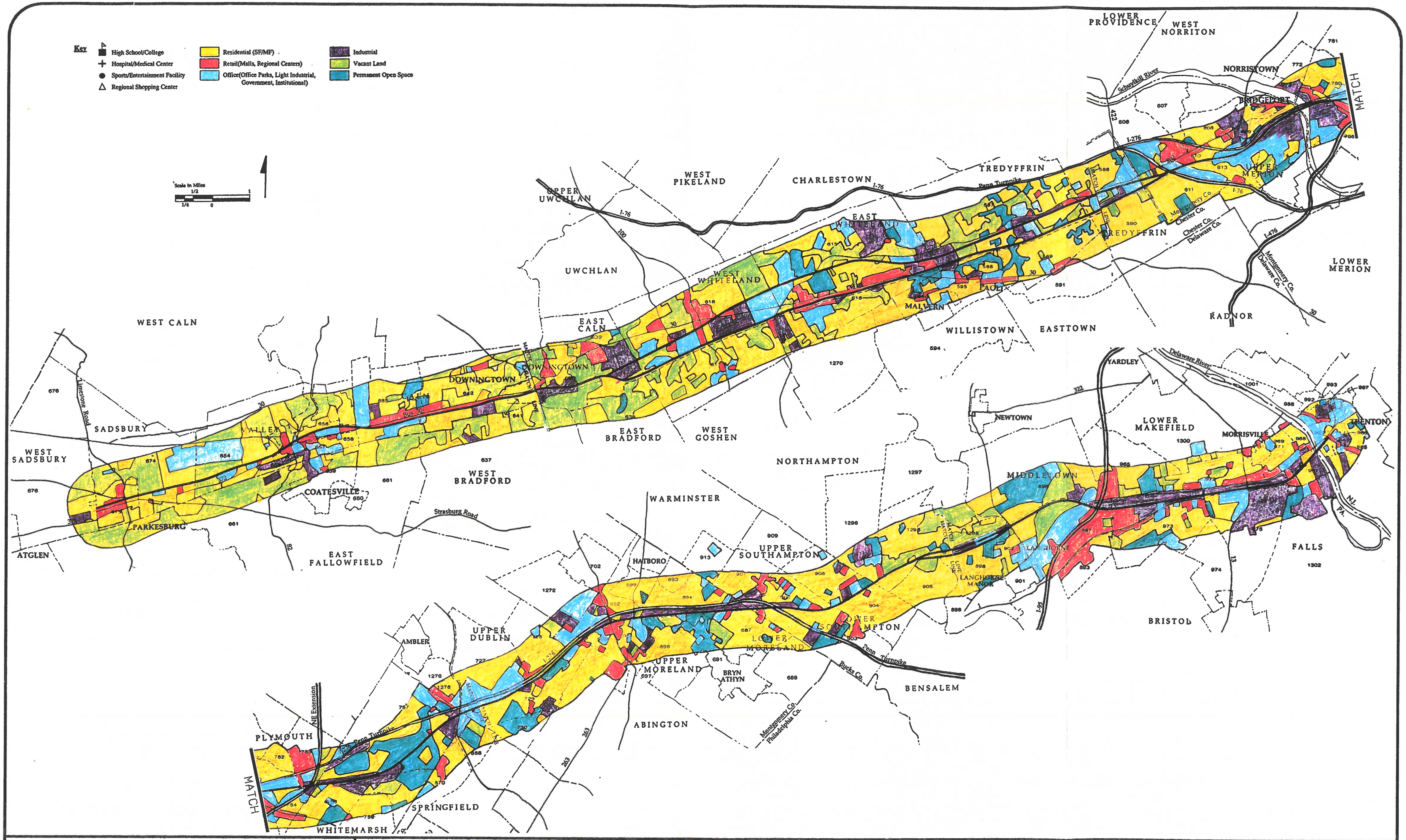
EXISTING LAND USE - 1990

EXHIBIT
3-7



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KISE FRANKS & STRAW

Cross County Metro

PROPOSED LAND USE - 2010

EXHIBIT
3-8

the corridor are the edges of the suburban communities which grew up around the Main Line such as Devon and Paoli. These areas are stable middle class communities and are unlikely to change significantly over the next twenty years. To the north, a series of new office parks and residential developments in Exton, Great Valley and Chesterbrook have increased residents and jobs in the area in recent years. Infill growth, similar in use and density to the recent development, can be expected to take place in this area of the county over the next twenty years.

Montgomery County

The Montgomery County portion of the corridor is already mostly developed, with only 12% of land remaining vacant. The two older communities of Norristown and Bridgeport, situated on either side of the Schuylkill River, are surrounded by underutilized old industrial sites. Three major regional shopping centers exist within the corridor in this county: King of Prussia, Plymouth Meeting and Willow Grove. Significant office development surrounds these centers. The remainder of the corridor is developed typically with tract single family housing. Some significant permanent open space, such as the Fort Washington State Park, also exists in Montgomery County.

By the year 2010 additional development and redevelopment can be expected to take place in this area of Montgomery County. The King of Prussia area is expecting major new growth in retail and office uses. Some of the underutilized industrial sites close to the river may be redeveloped for office and residential uses. Another major growth area is that area adjacent to the recently constructed I-476 and its intersection with the Pennsylvania Turnpike at the Northeast Extension where additional office and residential development can be expected.

Bucks County

East of I-95 in Bucks County, existing development is mostly residential with some vacant land remaining between communities. West of I-95 there is very little vacant land today. Development on this side of I-95 consists of a major retail complex surrounding Oxford Valley Mall which includes a seasonal amusement park--Sesame Place. Parallelling US Route 1 and closer to the river, there are large areas of industrial development and semi-abandoned industrial sites.

Trenton, New Jersey

The area of Trenton included in the study area is the downtown core where there is no significant undeveloped land today. Development consists of office uses, mid to high density residential uses and industrial sites. By the year 2010 a significant redevelopment of older industrial sites for office and residential uses is expected.

MORRISVILLE LINE

Conrail's Morrisville line runs for a total distance of 56.6 miles between Thorndale (west of Downingtown) in Chester County and Morrisville in Bucks County. It roughly parallels, in succession from west to east, portions of US Route 30, US Route 202, the Pennsylvania Turnpike and US Route 1.

The line was originally constructed by the Pennsylvania Railroad in the latter part of the nineteenth century as part of an extensive plan to segregate passenger and freight traffic and to provide additional capacity for growing freight traffic. The line was a key link in the Pennsylvania Railroad's main freight route between Harrisburg and the New Jersey/New York City area. For traffic moving between New Jersey/New York City and western points it provided a shorter alternative to a more congested route with steeper grades through Philadelphia. The line was constructed with double track, and was later electrified in the late 1930's.

The Morrisville line consists of two distinct sections. The portion between Thorndale and Glenloch, 10.6 miles long, was originally known as the Philadelphia and Thorndale. The portion from Glenloch to Morrisville, 46 miles, was originally known as the Trenton Cut-off. The Morrisville line is shown in schematic form on Exhibit 3-9.

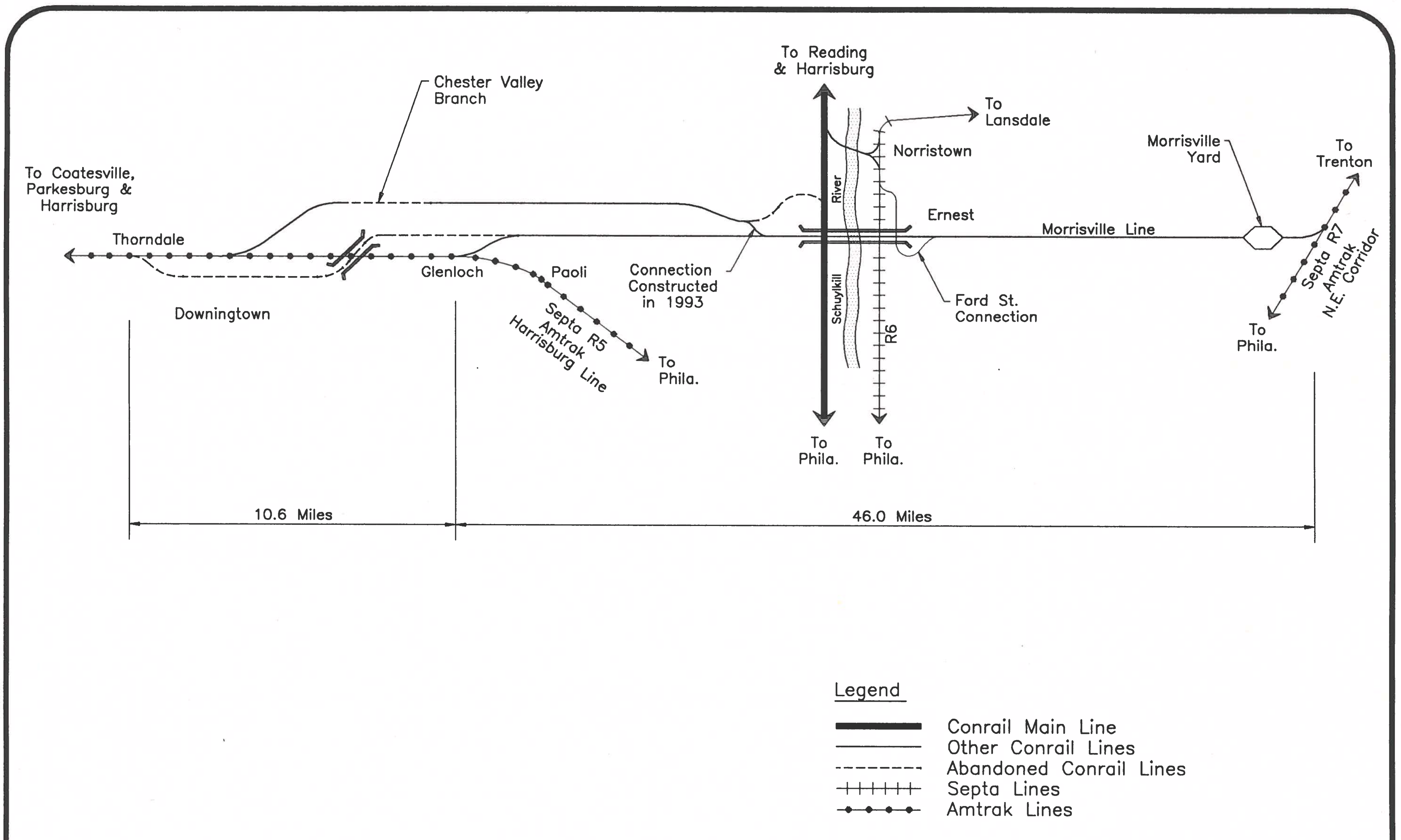
At the western end at Thorndale, the line connects to what is now Amtrak's Harrisburg line (formerly the Pennsylvania Railroad Main Line) with a grade separated arrangement which minimizes conflicts with opposing traffic. At Glenloch, a grade separated arrangement provides an additional connection to Amtrak's parallel Harrisburg line. At the eastern end in Morrisville the line connects to Amtrak's Northeast Corridor line with another grade separated arrangement.

Following the consolidation in 1976 of several eastern railroads to form Conrail, the function of the Morrisville Line changed considerably. Conrail chose to concentrate its traffic to and from the northern New Jersey/ New York City area on portions of the former Lehigh Valley and Reading Railroads and traffic to and from Philadelphia on the former Reading Railroad. Traffic on the Morrisville Line decreased dramatically. Conrail's use of electric locomotives was terminated in the early 1980's and the overhead wires were subsequently removed.

The Morrisville Line Today

Operations:

Today the Morrisville line provides access for rail traffic originating and terminating in portions of the Delaware Valley. Through freight traffic from points north and west reach the Morrisville line from Conrail's Philadelphia-Harrisburg Main Line in the vicinity of Ernest. Traffic from the Main Line operates through Norristown, interfacing for a short distance with SEPTA's Route R6 Regional Rail, and then reaches the



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MORRISVILLE LINE AND CONNECTIONS

EXHIBIT 3-9

Morrisville line over a track known as the Ford Street Connection. The traffic terminates at the Morrisville Yard at the east end of the line. Morrisville Yard serves freight traffic originating and terminating in the Trenton and Bordontown, New Jersey and Morrisville, Pennsylvania areas. There is also a terminal for intermodal traffic at Morrisville.

There are no local industries served between Ernest and Morrisville; however, west of Ernest the line is used for local freight access to industries in the Great Valley, Downingtown, and Coatesville areas. The western portion of the line between Glenloch and Thorndale is no longer used and is in the process of abandonment, with local freight traffic for Downingtown and Coatesville using the Amtrak Line in this area.

West of Ernest, a new connection has been constructed to serve local industries on the Chester Valley Branch, portions of which have been sold to Philadelphia Electric Company or will be removed for construction of the Exton Bypass highway.

Facilities:

- Track - From the Morrisville Yard to Ernest, the line has been reduced to a single track. That track is equipped with a signal system which permits operation of trains in either direction at normal speeds. The maximum grade in this section of the line is 0.67% and the sharpest curvature is 2 degrees.

  Between Ernest and Glenloch the line has also been reduced to a single track. In this section the signal system has been retired and local trains operate under train order. The maximum grade is 0.6% and the sharpest curvature is 1 degree 30 minutes.

Between Glenloch and Thorndale the line has also been reduced to a single track, and the remaining track is out of service pending abandonment. Here the maximum grade is 0.31% and the sharpest curvature is 2 degrees 45 minutes.

- Electrification - The catenary system (contact wires) have been removed from the entire line, but most of the support structures remain in place. West of Ernest, the structures still carry 138 KV transmission lines that are energized to feed power to Amtrak lines. East of Ernest, the high voltage transmission lines are out of service, and between Heaton and Woodbourne, a distance of approximately 11 miles, the transmission lines have been removed and replaced by a PECO Energy Company 220 KV transmission line which has been installed on the catenary structures.

  There are active substations at Thorndale and at Glenloch which still serve adjacent Amtrak Lines. There are no substations between Glenloch and Ernest. Between Ernest and Morrisville there are three substations which are out of service. At Morrisville an active substation still serves Amtrak's adjacent Northeast Corridor Main Line.

- Grade Crossings - There are three highway grade crossings on the line:
  - Bustleton Pike near Churchville
  - County Line Road at County Line
  - Gravers Road near Plymouth Meeting

CHAPTER 4

IDENTIFICATION OF TRANSIT ALTERNATIVES

IDENTIFICATION OF TRANSIT ALTERNATIVES

ALTERNATIVE MODES

Purpose

The primary purpose of defining the alternatives to be studied was not to focus on the exact technologies that would be used, but to cover a representative number of alternatives that could provide a reasonably wide spectrum of service and cost characteristics suitable for testing ridership and feasibility scenarios. Being representative, the particular modal technologies considered in this study do not represent a final selection.

Description of Alternatives

The first step in selecting the transportation modes to be considered in the study was to identify an array of various modes that would be potential candidates for consideration. These modes were grouped into three categories based on the general type of service they would provide relative to the Cross County Corridor:

- Trunk Line Modes - These are modes that would provide a trunk line service exclusively on the Morrisville line right-of-way with all access to the trunk line service based on transfer to and from connecting modes including auto and pedestrian access. An example of a trunk line service would be a rail line with stations that riders would reach by driving and parking, walking, or taking a bus or intersecting rail line. After riding the rail line to another station, riders would reach their final destination by walking or taking a shuttle bus. Except where origins and/or destinations are within walking distance of the trunk line, most trips would involve riding in three vehicles - an auto and two transit vehicles, or three transit vehicles.

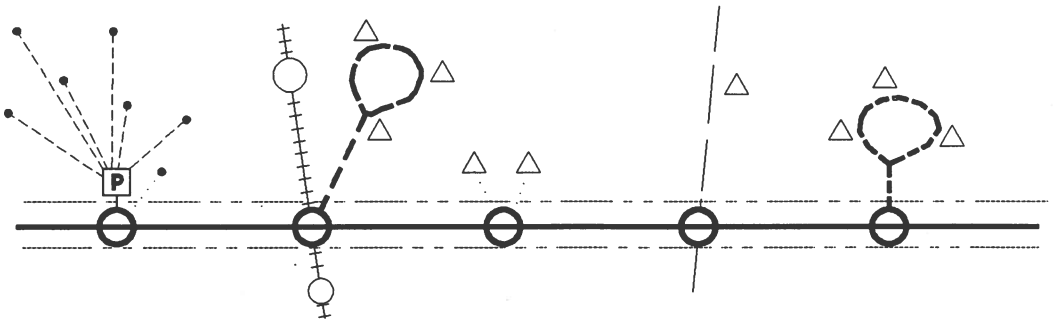
- Branch Line Modes - These are modes in which the same vehicle could operate partly on the Morrisville line right-of-way and then branch or temporarily divert off to provide service to and from destinations not immediately adjacent to the Morrisville line. An example of a branch line service would be buses which would start out on local roads providing service close to rider's homes, then operate over the busway for some distance, and then exit the busway and operate over local roads to deliver riders within walking distance of their destination. A rail service, such as light rail, could also be built with branches. A branch line service would offer the possibility of fewer transfers for some trips.

- Off Line Modes - These are modes that would operate within the Cross County Corridor and serve the same general travel market but would not make use of the Morrisville line right-of-way. The primary example of an off line mode would be a bus service operating over local roads and routed to stop within walking distance of origins and destinations. This type of service would offer the possibility of fewer transfers for some trips.

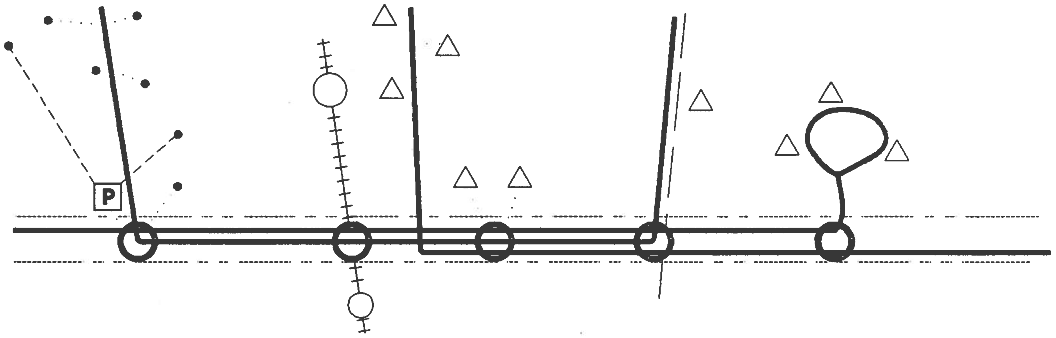
The three types of service are shown conceptually in Exhibit 4-1.

Initial Selection of Modal Alternatives (Step 1)

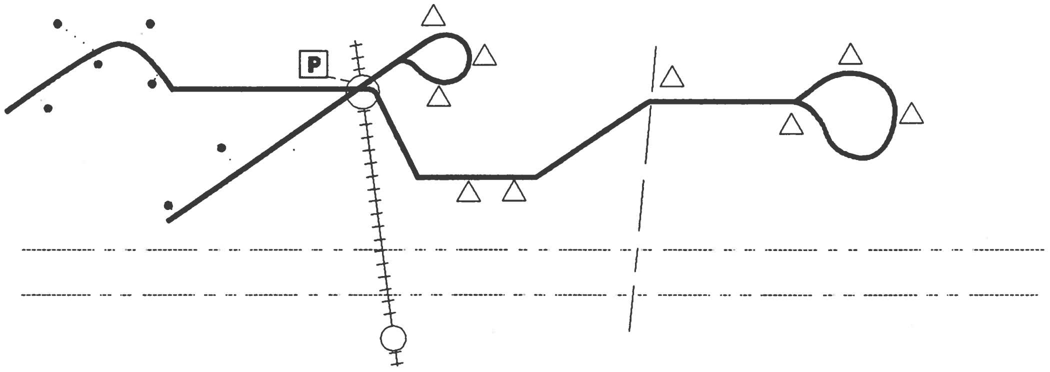
Based on their operational characteristics, the following potential modes were identified:



TRUNK LINE MODES



BRANCH LINE MODES



OFF LINE MODES

┈┈┈	MORRISVILLE LINE RIGHT OF WAY	┼┼┼┼┼┼	EXISTING RAIL ROUTE	P	NEW PARK AND RIDE LOT
━━━	CROSS COUNTY SERVICE	○	EXISTING STATION	------	AUTO ACCESS
━ ━	NEW FEEDER SERVICE	◯	NEW STATION	········	PEDESTRIAN ACCESS
— —	EXISTING BUS ROUTE	•	ORIGINS	△	MAJOR DESTINATIONS

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GENERAL SERVICE CONCEPTS

EXHIBIT 4-1

Trunk Line Modes:

- Existing Regional Rail - Electric: This mode would be identical to the existing SEPTA regional rail service in terms of vehicle and operating procedures.

- Existing Regional Rail - Diesel: Same as above except that diesel propulsion would be used.

- Modified Regional Rail - Electric: This mode would be identical to the existing SEPTA regional rail service except that the vehicles would be modified to allow staffing and operating procedures that would reduce operating costs such as one person operation.

- Modified Regional Rail - Diesel: Same as above except that diesel propulsion would be used.

- Electric Light Rail: This mode would employ rail vehicles using modern light rail (LRT) technology. Because of their lighter construction and other details, light rail vehicles are normally not suitable for operation on the same tracks as freight and intercity passenger trains but are capable of operating over a variety of other rights-of-way including in streets with other vehicles. In this case they would not be able to operate on the existing regional rail tracks (including Amtrak). Light rail vehicles are typically designed for one person operation.

- Diesel Light Rail: Same as above except that in this case the vehicles would be powered by an internal combustion engine (diesel, gasoline, or other type of fuel). There are no examples of this type of mode in North America but the vehicles could resemble the British "Railbus" which tested in the Philadelphia area in the early 1980's.

- Busway: This mode would employ conventional buses operating on an exclusive roadway only. The busway would be constructed within the Morrisville line right-of-way but would be separated from rail freight operations. The busway would provide trunk line service that would connect with other bus and rail services in the corridor.

- Automated Guideway: This mode would employ a fixed guideway system (such as rail) operating on a fully separated guideway free of intersection or crossings with highways and other rail lines. It would be fully automated with self service fare collection. Propulsion would be electrically derived.

- Alternative Guideway: This mode would employ a fixed guideway technology other than conventional rail such as monorail, maglev or other emerging transit technology.

Branch Line Modes:

- Busway with Branches: This mode would employ conventional buses operating partially on existing roads and streets and partially on an exclusive trunk line roadway constructed within the Morrisville line right-of-way.

- High Occupancy Vehicle and Busway: This mode would employ a combination of conventional buses, car pools, and vans operating partially on existing roads and streets and partially on an exclusive roadway constructed within the Morrisville line right-of-way, the Pennsylvania Turnpike, or US Route 202 or a combination of these rights-of-way.

- Electric Light Rail Transit with Branches: This mode would employ electric light rail vehicles operating partially on a trunk line on the Morrisville line right-of-way and partially on branches or diversions either newly constructed or using other rail rights-of-way, reaching out to areas not immediately adjacent to the Morrisville line right-of-way.

- Diesel Light Rail Transit with Branches: This mode would be the same as above but would employ internal combustion powered light rail vehicles.

- Automated Guideway with Branches: This mode would employ some form of easily switched guideway (such as rail) capable of full automation and selective operation off the trunk line portion of the system to and from branches constructed to serve points not immediately adjacent to the Morrisville Line.

- Alternative Guideway with Branches: This mode would employ a fixed guideway technology (other than conventional rail) that would include branches constructed to serve points not immediately adjacent to the Morrisville Line.

Off Line Modes:

- Improved Bus Service: This mode would employ conventional buses operating on existing streets and roads in a revised and expanded route system designed to provide improved service in the corridor. Likely options for expanded service would be on the Pennsylvania Turnpike and US Route 202 as well as on a limited number of other routes where demand warrants.

- Improved Bus Service with Transportation Systems Management: This mode would employ conventional buses operating on existing streets and roads in a revised and expanded route system that would enjoy the benefits of TSM strategies that would improve the performance of the bus operations.

- Improved Bus Service using High Occupancy Vehicle (HOV) lanes on major highways parallel to the corridor: This mode would employ conventional buses operating on existing streets and roads and on exclusive lanes primarily on the Pennsylvania Turnpike (and possibly US Route 202).

Evaluation Assumptions

The following general assumptions were applied to evaluate and narrow the selection of alternatives:

- In order to facilitate transfers among modes under the trunk line alternatives, headways must be in the range of 15 to 30 minutes or less.

- Conrail will require one track for freight operations and this track will have to be reserved solely for freight operations. This will mean that the transit mode will need to be able to operate on a single track (with strategically placed passing tracks) or will need to incur additional capital costs for right-of-way work and bridge widening in most areas.

- A single lane busway is not feasible because the high volume of buses that would be using the busway and the variability of their arrival from local streets and roads would be greater than the capacity of the roadway.

- Because the Pennsylvania Turnpike has recently been widened between the Plymouth Meeting and Philadelphia interchanges to provide an additional lane to relieve congestion, establishing an HOV lane in the turnpike corridor will require very expensive construction of an additional lane including widening of bridges and probable taking of adjacent property. It is not expected that a Cross County Metro service would reduce other vehicular traffic sufficiently to allow the recently constructed lane to be dedicated to HOV.

- The potential ridership levels of a suburban circumferential service will not be sufficient to support construction of alternative modes with very high capital costs for special guideways and automatic operation unless the maximum benefits of high service levels and low operating costs can be fully realized.

Refinement of Study Alternatives (Step 2)

Following review by the Technical Advisory Committee, the following modes were retained for further consideration:

- A form of regional rail providing a trunk line service on the Morrisville line. This could be identical to SEPTA's existing regional rail services or a modified version in which the vehicles and fare collection system would be specially designed to allow single person train operation. The vehicles would be capable of providing through service to points beyond the Morrisville line over existing Amtrak and SEPTA lines. All access to the service would be through transfer to and from other modes including rail, bus, auto, bicycle and pedestrian. Other modes such as bus would be expanded to provide an enhanced feeder service primarily to employment centers and other major destinations.

- A light rail service providing a trunk line service on the Morrisville line right-of-way. The service would employ either conventional electric light rail vehicles or a non-electric (diesel, gas, alternative fuel) version.

- A two lane busway on the Morrisville line right-of-way that would accommodate buses whose routes would extend off the busway over local streets and roads to closely serve areas of origins and destinations. Existing bus routes would be expanded and restructured to make use of the busway.

- A light rail service on the Morrisville line right-of-way with selected branch line extensions or diversions to major origin/destination areas such as Norristown. Complimentary expansion and restructuring of other modes to enhance feeder services would be included. Because of the potential for reduced construction costs in an existing right-of-way, a non-electric version (diesel, gasoline or alternative fuel) would also be considered.

- A fully automated guideway (rail) system that would operate without drivers or attendants on board or at stations and provide a very frequent trunk line service in addition to direct operation on selected branches to major traffic generators. The alternative would include complementary expansion and improvement of other modes to enhance feeder services where construction of branches is not justified.

- An improved and expanded bus service operating over existing streets and highways in conjunction with Transportation Systems Management (TSM) strategies. The route structure would be designed to better serve major employment and residential areas and to optimize transfers, including express service to existing rail lines. TSM strategies could include enhanced traffic signals, turning lanes, pull-off lanes at bus stops, expedited arrangements for buses using the Pennsylvania Turnpike, and other general traffic improvements on bus routes.

Evaluation Criteria (Step 3)

Each alternative identified above was evaluated against a number of characteristics. These characteristics are grouped into three categories of concerns:

User Concerns

These are characteristics that are primarily of significance to the rider in choosing whether or not to ride. Fares are not included because in a public transportation system, they are, to an extent, a matter of policy that may or may not be correlated with a particular mode of transportation.

- Number of Transfers. This is the number of times that a patron would be expected to have to transfer between transit vehicles or between auto and transit vehicles.
- Transfer Time. This is the length of time patrons would be expected to have to wait to make a transfer.
- Initial Access. This is the ease of accessibility for patrons starting their journey on a Cross County service.
- Final Access. This is the ease with which patrons can reach their final destinations after having boarded a Cross County service.

- Headway. This is the time between vehicles. It not only affects transfer times, but also affects waiting times for pedestrians or drivers who arrive randomly at their station. It also affects the convenience of the service to all patrons by determining the choices they have available in scheduling their trips.

- Speed. This is the average operating speed, including stops, which each alternative can attain. Along with headways, transfers, and distance traveled, it directly affects the patron's total travel time, and in some situations, may drive modal choice. (It is also a concern to the operator in that it affects vehicle requirements and driver productivity).

- Comfort. This is the relative riding comfort of the different alternatives based on vehicle and guideway characteristics.

- Flexibility. This refers to the ability of a Cross County Service to be easily expanded or extended to better serve additional markets.

Operator Concerns

These are characteristics that are of primary significance to the transit authority who would plan, construct, and operate the service.

- Right-of-Way Costs. This is the construction costs for the guideway and would include earthwork, bridges, track or pavement, signaling, and electrification facilities.

- Station Costs. This is the cost of stations on the trunk line and, for the Branch Line modes, stations on the branches.

- Vehicle Costs. This is the cost of vehicles for the proposed services.

- Maintenance Facility Costs. These are the capital costs associated with new or expanded storage and maintenance facilities which may be required for the vehicles providing a Cross County service.

- Property Costs. These are costs for additional right-of-way that may have to be purchased for each option.

- Driver Costs. These are the costs of the on-board labor to operate the vehicles.

- Power Costs. These are the costs of fuel or electricity to operate the vehicles.

- Vehicle Maintenance Costs. These are costs for overhaul, maintenance and inspection of the vehicles.

- Right-of-Way Maintenance Costs. These are the costs for maintenance of guideway (track or pavement), stations, signal and traction power systems, and related fixed facilities.

- Physical Implementation. This is the relative ease or difficulty of putting the facilities in place.

- Institutional Implementation. This refers to concerns about major changes required to operating procedures, policies and staffing arrangements, related concerns about safety and security, and difficulties related to needs for inter-agency cooperation.

- Technological Risk. This relates to concerns about risks associated with the expected performance of the system put into place.

Community Concerns

These are characteristics of the alternative that would be of significance to the community at large and include the larger goals of the proposed service. One of the primary goals, reduced congestion and its related benefits, is not listed here because it depends on the ability of the service alternative to attract riders which was estimated at a later stage of the study. This is discussed in Chapter 8.

- Air Quality. This refers to pollution associated with the particular mode.
- Noise. This refers to the noise emitted by the vehicles for each alternative.
- Development Focus. This refers to the ability of a particular mode to attract development into more efficient, focused patterns.

Alternative Ranking and Selection (Step 4)

For each concern, each alternative was rated within the range of alternatives as generally good (a plus), fair (a zero), or poor (a minus). Exhibit 4-2 shows values of 1, 0, or -1 for the good, fair and poor ratings respectively, and these values are subtotaled for the User Concerns, Operator Concerns and Community Concerns. The total of all values are shown at the bottom of the table. The scope of the project required that four alternatives be selected for detailed analysis.

Exhibit 4-2

COMPARISON OF ALTERNATIVES

"+" = GOOD (+1)
"0" = FAIR (0)
"-" = POOR (-1)

	TRUNK LINE MODES						BRANCH LINE MODES				OFF LINE MODE
	REGIONAL RAIL				LIGHT RAIL		BUS WAY	LIGHT RAIL		AGT	TSM (BUS)
	EXISTING		MODIFIED								
	ELEC	DSL	ELEC	DSL	ELEC	DSL		ELEC	DSL		
USER CONCERNS											
NUMBER OF TRANSFERS	-	-	-	-	-	-	0	0	0	0	0
TIME OF TRANSFERS	-	-	0	0	0	0	0	0	0	+	0
INITIAL ACCESS	-	-	-	-	-	-	+	0	0	0	+
FINAL ACCESS	-	-	-	-	-	-	+	0	0	0	+
HEADWAY	-	-	0	0	0	0	0	0	0	+	0
SPEED	+	+	+	+	+	+	0	+	+	+	-
COMFORT	+	+	+	+	+	+	0	+	+	+	-
FLEXIBILITY	+	0	+	0	0	0	+	0	0	-	+
SUBTOTAL	(2)	(3)	0	(1)	(1)	(1)	3	2	2	3	1
OPERATOR CONCERNS											
RIGHT OF WAY COSTS	0	+	0	+	0	+	-	-	0	-	+
STATION COSTS	0	0	0	0	0	0	0	0	0	-	+
VEHICLE COSTS	+	-	0	-	-	-	+	-	-	-	+
FACILITY COSTS	+	0	+	0	0	-	+	0	-	-	+
PROPERTY COSTS	+	+	+	+	+	+	0	0	0	0	+
DRIVER COSTS	-	-	0	0	0	0	0	0	0	+	0
POWER COSTS	+	+	+	+	+	+	0	+	+	+	0
VEHICLE MAINTENANCE COSTS	+	0	+	0	+	0	0	+	0	+	0
R/W MAINTENANCE COSTS	-	-	-	-	-	-	0	-	-	-	+
PHYSICAL IMPLEMENTATION	+	+	+	+	+	+	-	-	-	-	+
INSTITUTIONAL IMPLEMENTATION	+	+	0	0	+	+	+	+	+	-	0
TECHNOLOGICAL RISK	+	+	+	+	+	0	+	+	0	-	+
SUBTOTAL	6	3	5	3	4	2	2	0	(2)	(5)	8
COMMUNITY CONCERNS											
AIR QUALITY	+	0	+	0	+	0	-	+	-	+	-
NOISE	+	0	+	0	+	0	-	+	-	+	-
DEVELOPMENT FOCUS	0	0	0	0	0	0	0	0	0	+	-
SUBTOTAL	2	0	2	0	2	0	(2)	2	(2)	3	(3)
TOTAL	6	0	7	2	5	1	3	4	(2)	1	6

Urban Engineers, Inc. 1993

The order of ranking of the alternatives is as follows:

Modified Electric Regional Rail
Existing Electric Regional Rail
Bus with TSM Improvements
Electric Light Rail in Trunk Line Service
Electric Light Rail in Branch Line Service
Busway
Modified Diesel Regional Rail
Diesel Light Rail in Trunk Line Service
Automated Guideway Transit (AGT)
Existing Diesel Regional Rail
Diesel Light Rail in Branch Line Service

The study sought to determine the ability of a range of different alternatives to generate ridership. Therefore, the final selection avoided alternatives with similar service characteristics.

Since both versions of Electric Regional Rail would have similar service characteristics, only one was selected for detailed analysis. Because of concerns over the ability to implement single person operation, especially where the trains would operate on Amtrak lines, the existing version was selected. The modified version with its lower operating costs for similar levels of service was considered as a possible candidate for further evaluation through sensitivity analysis of operating costs.

The Electric Light Rail in Trunk Line Service would provide similar service capabilities as the Regional Rail alternative, therefore the Branch Line version was selected for detailed analysis.

In summary the following four alternatives were selected and agreed to by the Technical

Advisory committee for further evaluation during the remainder of the study:

- Electric Regional Rail in Trunk Line Service.
- Electric Light Rail with Branches or Diversions
- Busway
- Improved Bus with TSM Improvements.

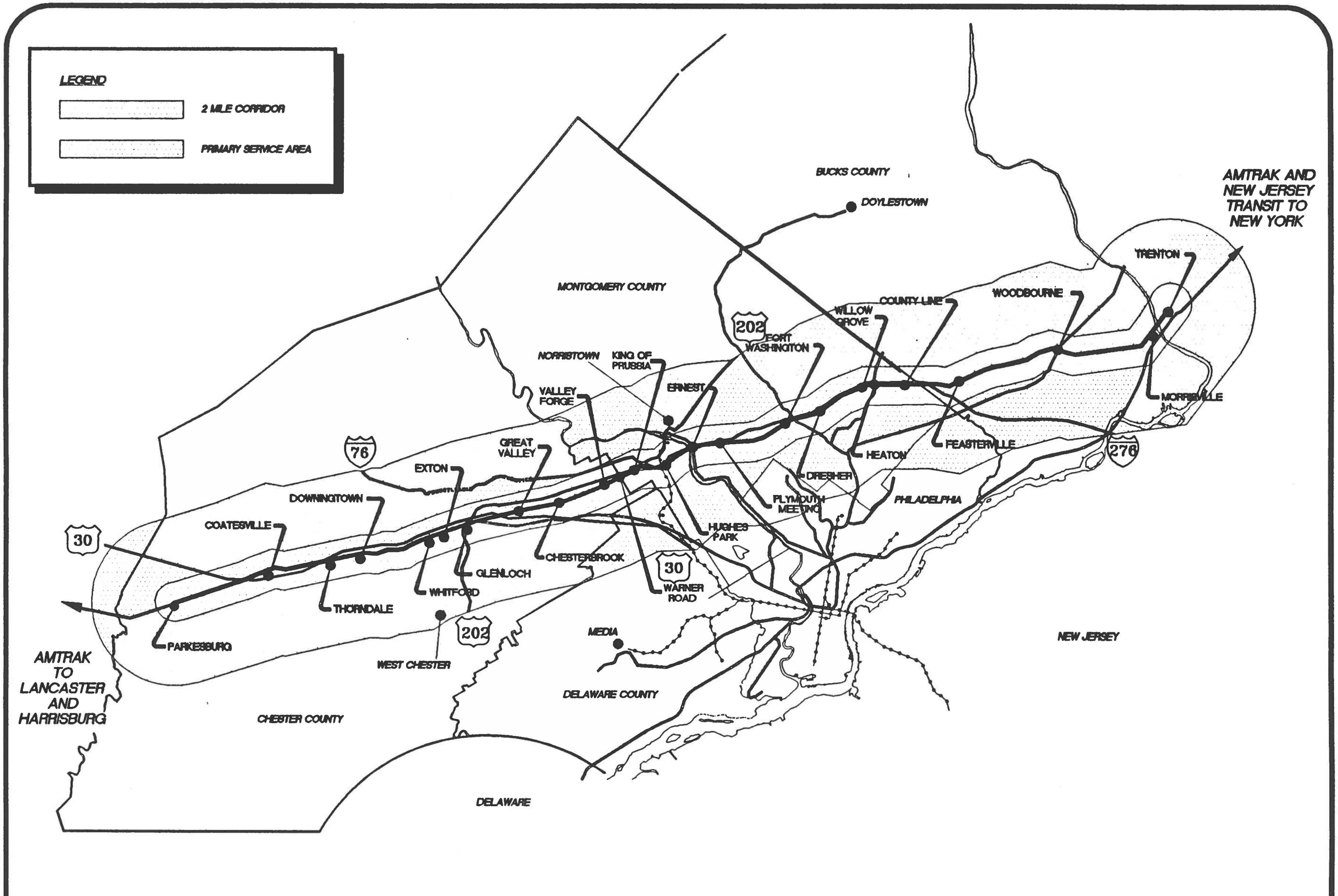
As reflected in the study's scope of services, it was noted that following an initial modeling of the four selected alternatives, the results might suggest that a combination of two or more alternatives, each serving selected portions of the corridor may be appropriate for implementation.

STATION LOCATIONS

In selecting station locations, priority was primarily given to connections with existing SEPTA rail lines and bus services, opportunities to develop park and ride access from major highways and potential to develop shuttle bus connections to nearby office developments. Potential for future development in the vicinity of stations was also considered. Walk in access was not a significant factor at most locations. Sites were selected using aerial photographs, USGS mapping, and transit and highway maps. Appendix 1 to this report includes schematic plans of each proposed station location. These plans indicate possible platform locations, parking and access. Additional study will be required to determine the exact location and size of each facility.

The following station locations (see Exhibit 4-3) were selected for purposes of the feasibility study:

Parkesburg: Existing station
Coatesville: Existing station
Thorndale: Station already planned for this location



Urban Engineers, Inc.
300 N. 3rd Street
Philadelphia, PA 19106-1193

Cross County Metro

PRELIMINARY STATION LOCATIONS

EXHIBIT
4-3

Whitford: Existing station

Exton: Existing station

Glenloch: This station would be located at the junction of the Cross County Metro with the R5 Regional Rail Line. A Light Rail service would provide cross platform connection to the R5 trains; a Regional Rail service could operate through to Downingtown. The site offers good park and ride access from US Route 202 and direct connection to SEPTA bus Route 92 serving the Whiteland Corporate Center and other development along U.S. Route 30. A private bus service between West Chester and Downingtown could be diverted to this station. There is the opportunity for future shuttle access to the Church Farm School site, if and when development occurs. The planned Route 30 Exton Bypass will improve park and ride access to the area. The platform location would be located to provide the opportunity for connection between the R5 trains and the Cross County Metro with minimal changes to track alignments. This transfer will be necessary for the Light Rail alternative but also desirable for the Regional Rail alternative. A proposal by a developer to provide a station west of the US Route 202 crossing to serve the planned Glenloch Campus development suggests that the platform may be located further west at greater cost with the possible assistance of private funding.

Great Valley: This station would be located where the Cross County Metro crosses US Route 30. In addition to park and ride access from Route 30 and nearby U.S. Route 202, the location offers connection with SEPTA Bus Route 206 serving Paoli and the nearby Great Valley Corporate Center.

Chesterbrook: This station, located at PA Route 252, would provide connection with SEPTA Bus Route 92 which provides service through the nearby Chesterbrook Corporate Center. Park and ride access to this site may be difficult to develop due to topography. Parking would have to be developed beneath PECO transmission lines.

Valley Forge: This station would be located at West Valley Road. This station could anchor one end of a shuttle service that could serve Devon Park Drive, the Valley Forge Executive Mall, and the Chesterbrook Corporate Center. There is walk in access from adjacent town house residential development. Park and ride will be difficult to provide at this location.

Warner Road: This station would be a primary park and ride station for traffic entering the corridor on US Route 422. Southbound Route 422 traffic would reach the station via Swedesford Road. Northbound traffic from the station would enter Route 422 via Devon Park Drive.

King of Prussia: This station would be located at Gulph Road providing direct connection with SEPTA Bus Route 125 serving the King of Prussia Mall and Industrial Park and Route 205 between Wayne and King of Prussia. Additional SEPTA bus routes serving the mall could be extended to this station. There is park and ride access from U.S. Route 202. Township plans for rezoning the adjacent property for high density development provides the opportunity for future walk in access as well as possible development of a people mover type shuttle service to the mall and adjacent areas.

Hughes Park: This station would provide for transfer to and from SEPTA Route 100 (the Norristown High Speed Line). Park and ride access would be from Crooked Lane. Shuttle buses could provide service to development along Swedeland Road. For the Light Rail alternative, which would divert onto the Norristown High Speed Line to reach Norristown, transfer to and from Route 100 could take place at the existing King Manor Station on the Route 100 line.

Ernest: This station would provide for transfer between the Cross County Metro and SEPTA Regional Rail Route R6. At this location the Cross County Metro would be on a high bridge above the R6 line, and stairs and elevators would be required to reach each platform on the R6 line. Due to the difficult topography and lack of nearby highways, this station is proposed as a transfer station only with no vehicular or walk in access.

Plymouth Meeting: This station would provide connection to SEPTA Bus Routes 27, 95, and L serving Plymouth Meeting Mall. There would be park and ride access from I-476 (Blue Route) and the Pennsylvania Turnpike including the Northeast Extension. There is walk in potential from office development south of Chemical Road. There is the potential for shuttle bus service to future development on the Alan Wood Steel site.

Fort Washington: This station would provide for transfer to and from the R5 Regional Rail service. Because this site is tightly bound by limited access highways and includes environmentally sensitive areas, roadway access and parking would be very difficult and costly to provide. Therefore this location is proposed as a transfer station only with no vehicular or walk in access.

Dresher: This station would be located at Susquehanna Road from which shuttle bus service to the nearby Fort Washington Office Center could be provided by extension and improvement of the existing Route 201 bus.

Willow Grove: Located at Easton Road, this station would provide the opportunity for a shuttle bus service to several nearby office developments as well as the transit hub at the Willow Grove Mall. The station would also be directly served by Bus Route 55.

Heaton: This station would provide direct connection to SEPTA Regional Rail Route R2. SEPTA Bus Route 22 could be re-routed to serve this station. Joint parking could be developed with an adjacent supermarket that has a very large parking lot. Eastern Montgomery County Vo-tech is nearby.

County Line: This station would be developed if and when rail service is restored on the R8 Regional Rail line to Newtown. Access to the site is difficult. Park and ride access from Byberry Road could be developed with an access road. The site would also offer walk in access to an adjacent industrial park.

Feasterville: This station would be located at Street Road. Nearby SEPTA Bus Route 58 could be diverted to serve this station.

Woodbourne: This station would provide direct connection to SEPTA's R3 Regional Rail service and park and ride access from I-95 and US Route 1. The already developed interchange of I-95 and Route 1 makes vehicular access difficult. An access road could be constructed from Big Oak Road to the north with access from I-95 and Route 1 via Big Oak Road and Oxford Valley Road. Access from Woodbourne Road to limited parking could be developed through the Existing Woodbourne R3 station which would be relocated. It is expected that the I-95 improvement project will improve access to this station. SEPTA bus routes serving nearby Oxford Valley Mall could be extended to serve this station. Major development has been proposed for this location.

Morrisville:	This station would need to provide for transfer to and from SEPTA's Regional Rail Route R7 for the light rail alternative. The Regional Rail alternative could run directly into Trenton to provide connection to the R7 as well as Amtrak and New Jersey Transit. A light rail station could be developed in conjunction with the Conrail Bridge over the R7 route. The regional rail station would have to be situated differently in order to provide transfer to and from the R7 line and still continue into Trenton. This alternative would require expensive overpasses and underpasses to reach the connecting platforms and parking lots. For both alternatives, park and ride could be developed adjacent to Philadelphia Avenue.
Trenton:	This is an existing station.

SERVICE LEVELS

In developing a service plan for each of the four alternatives, it was recognized that good connection with feeder services would be important to the ability of a Cross County service to attract riders since many of the origins and destinations are not within convenient walking distance of stations. It was assumed that the present SEPTA suburban route structure had been fine tuned to serve the local markets and should not be significantly re-structured. Rather, the proposed Cross County services seek to complement the existing pattern of suburban bus services with selected additional shuttle services serving major employment centers, improved headways and service extensions for existing shuttle services, and minor relocation of existing routes to serve proposed stations. The existing pattern of routes meeting at transportation centers was preserved.

Headways for the Cross County services were set at 15 minutes during peak hours and 30 minutes during offpeak hours. Connecting shuttles which would primarily serve employment centers would have 15 minute headways during peak hours and 60 minute headways during off peak hours. Where new shuttle routes overlay existing longer routes with much longer headways, the shuttle service would be supplemental to the existing service.

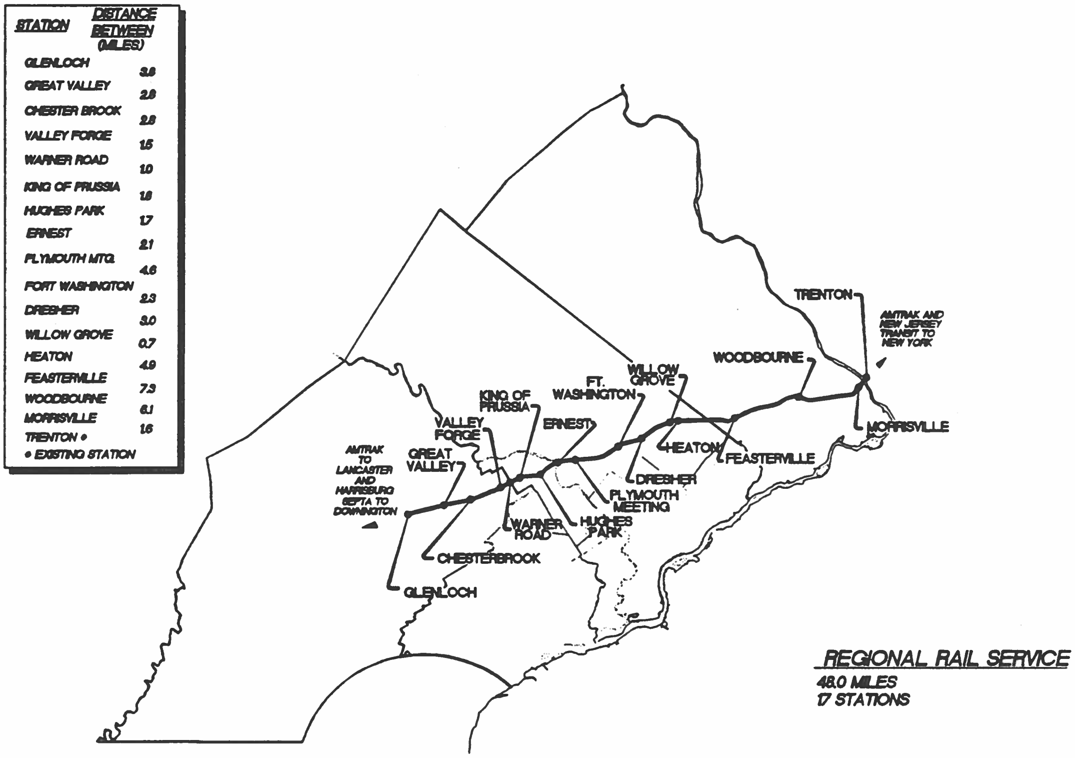
Exhibits 4-4 through 4-7 show route maps, station locations, and service characteristics for each of the four alternative modes selected for detailed study. Appendix 2 of this report provides, in schematic form, additional information on the routing of connecting services, and Appendix D of the Technical Appendix provides a tabulation of all existing and proposed headways of connecting services.

The Regional Rail alternative service was originally defined to operate from Downingtown in Chester County to Trenton in Mercer County. The western portion of the service between Downingtown and Glenloch would operate on Amtrak's Harrisburg line and would overlay the existing service provided by SEPTA's Regional Rail Route R5. The line loadings resulting from the ridership analysis indicate a significant drop off in ridership west of Chesterbrook station while operating trains in this segment would generate significant additional operating costs. Consequently, in order to improve the performance of the Regional Rail alternative, the western end of the service was cut back from Downingtown to Glenloch.

Although Glenloch is still west of Chesterbrook, this location for the western terminus was chosen because it is the junction point with SEPTA's existing R5 service and would thus afford the opportunity for riders to and from points west to transfer between the R5

Exhibit 4-4

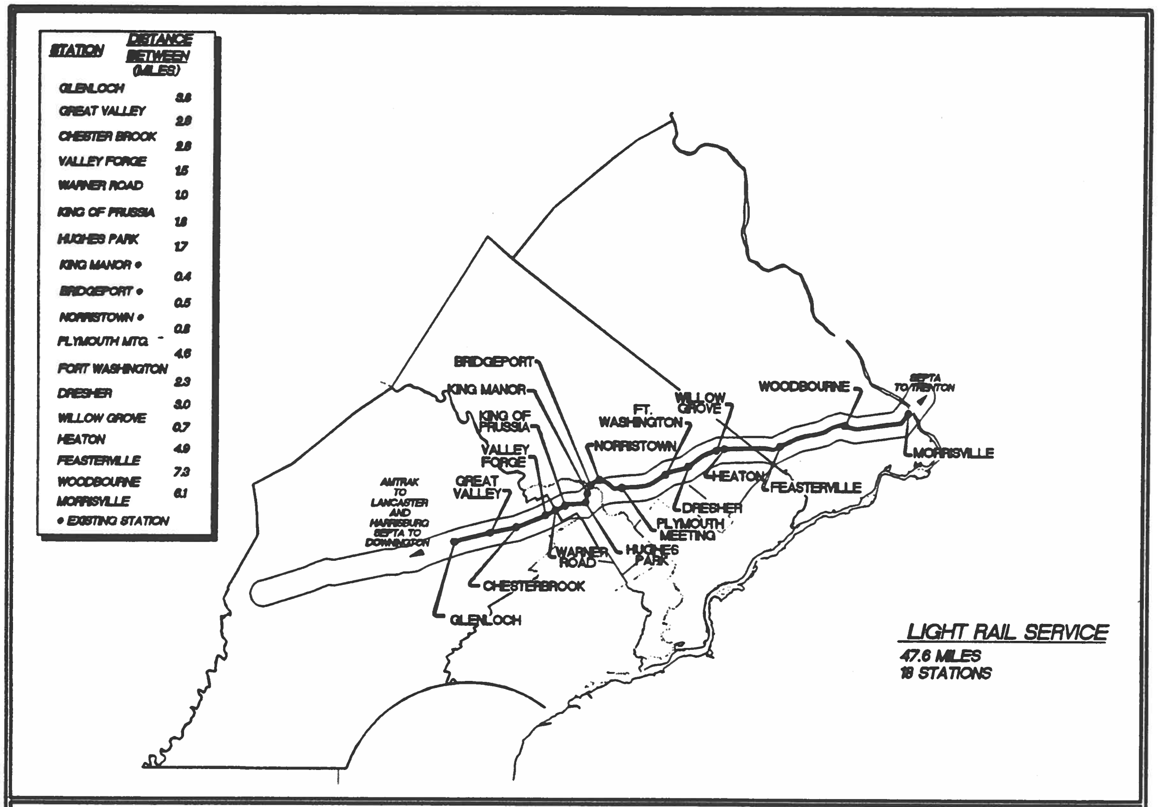
REGIONAL RAIL ALTERNATIVE



A trunk line service would operate from Glenloch through to Trenton. Direct connection with Amtrak and SEPTA Regional Rail Route R5 trains would be possible at stations between Glenloch and Downingtown, and with Amtrak, New Jersey Transit, and SEPTA Regional Rail Route R7 trains at Trenton, and R7 trains at Morrisville. Intermediate stations would provide connection with all intersecting Regional Rail and High Speed lines as well as most intersecting bus routes. Connecting shuttle bus routes would be established between selected stations and nearby major office and industrial parks. These would include new shuttle services, improved existing shuttle services, and minor re-routing of existing bus routes. The Woodbourne station would be developed as a secondary transit hub by extending existing routes from the nearby Oxford Valley Mall. The route would operate with vehicles similar to SEPTA's existing regional rail fleet. The trains would operate on a single track with passing sidings at a top speed of 80 mph. Stations would have high level platforms. Trains would operate every 15 minutes during peak hours and every 60 minutes at other times.

Exhibit 4-5

LIGHT RAIL ALTERNATIVE



STATION	DISTANCE BETWEEN (MILES)
GLENLOCH	3.8
GREAT VALLEY	2.8
CHESTER BROOK	2.8
VALLEY FORGE	1.5
WARNER ROAD	1.0
KING OF PRUSSIA	1.8
HUGHES PARK	1.7
KING MANOR •	0.4
BRIDGEPORT •	0.5
NORRISTOWN •	0.8
PLYMOUTH MTG.	4.6
FORT WASHINGTON	2.3
DRESHER	3.0
WILLOW GROVE	0.7
HEATON	4.9
FEASTERVILLE	7.3
WOODBOURNE	6.1
MORRISVILLE	

• EXISTING STATION

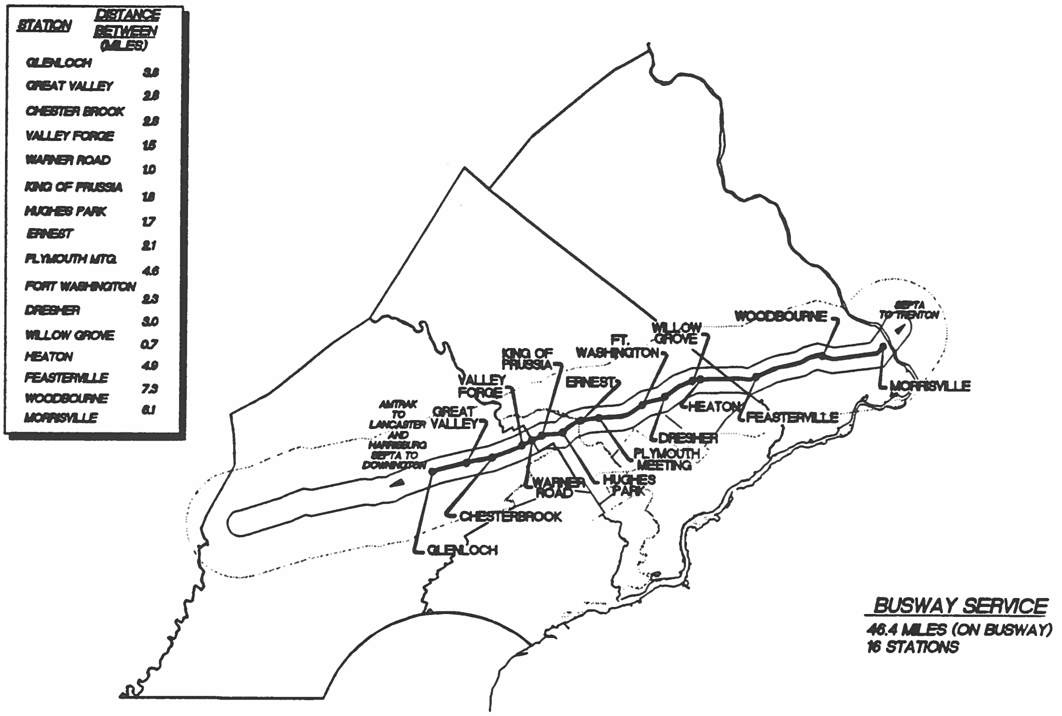
LIGHT RAIL SERVICE

47.6 MILES
18 STATIONS

A trunk line service would operate between Glenloch and Morrisville via Norristown using the existing Norristown High Speed Line right-of-way between Hughes Park and Norristown and existing Conrail right-of-way between Norristown and Ernest (west of Plymouth Meeting). Access to Downingtown and Parkesburg would be via transfer to existing R5 trains at Glenloch and to Trenton via transfer to existing R7 trains at Morrisville. Shuttle bus routes and improved connecting services would be the same as for the Regional Rail alternative. Except for the portion of the Norristown High Speed Line between Hughes Park and Bridgeport, the trains would operate on a single track with passing sidings at a top speed of 80 miles per hour. The cars would be articulated light rail vehicles similar to those used on new light rail systems in other North American cities. Stations would have high platforms. Trains would operate every 15 minutes during peak hours and every 30 minutes at other times.

Exhibit 4-6

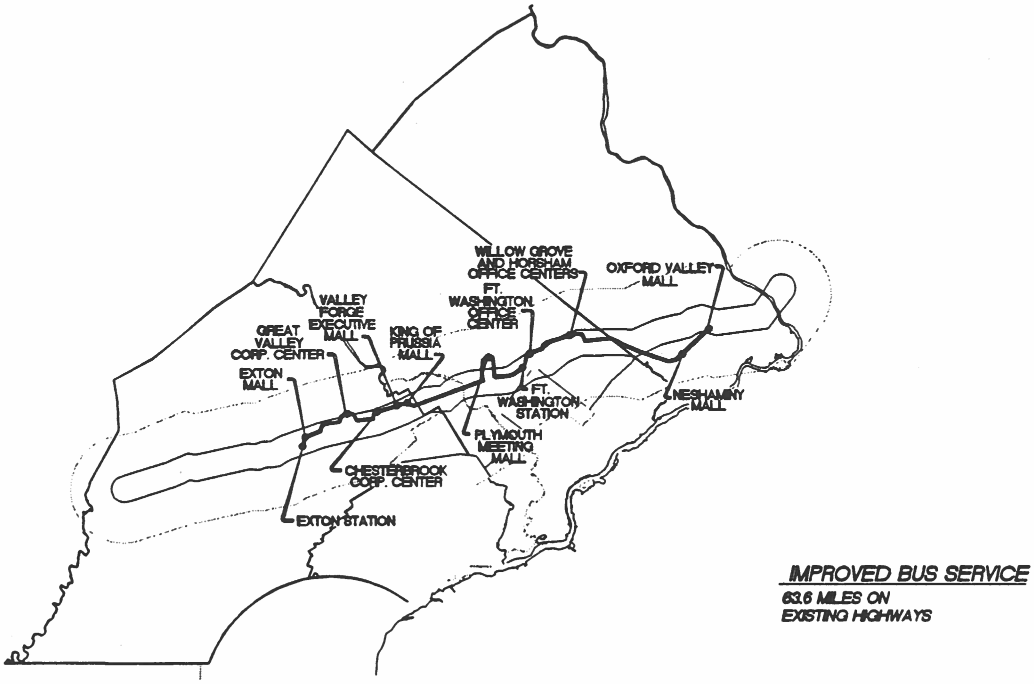
BUSWAY ALTERNATIVE



The busway would extend between Glenloch and Morrisville. Two services would operate on the busway: (1) A trunk service between the Exton Mall and Exton R5 Rail Station and Trenton via US Route 30 west of Glenloch and local highways east of Morrisville and (2) a local service between the Great Valley Corporate Center and the Oxford Valley mall via local roads west of Great Valley and east of Woodbourne. The local service would also leave the busway and operate over local roads to serve existing transit hubs at malls and transportation centers and selected intermediate major employment centers. Transfer to and from other transit routes could take place at busway stations and at the existing transit hubs. Selected existing bus routes would be diverted to serve nearby busway stations. On the two lane busway, buses would operate at a top speed of 55 mph. Stations would be served by low platforms. Both the trunk and local routes would operate every 15 minutes during peak hours (providing a combined headway of 7.5 minutes on the busway) and every 60 minutes at other times (providing a combined headway of 30 minutes)

Exhibit 4-7

IMPROVED BUS ALTERNATIVE



This alternative would provide a combination express and local service over existing roads and would provide connections with existing transit routes at transit hubs. It would also serve selected intermediate major employment centers. The express portions of the route would make use of portions of US Route 202, the Pennsylvania Turnpike with expedited access at interchanges, and US Route 1. TSM improvements could be implemented to expedite bus movements in and out of the transit hubs in congested areas. Bus speeds would be governed by speed limits and traffic conditions. Buses would operate every 15 minutes during peak hours and every 30 minutes at other times.

service and the Cross County service. Connecting the lines at this location will also afford access to SEPTA's Frazer maintenance facility as well as provide additional connection to SEPTA's regional rail network for operational flexibility. By not running the Cross County service west of Glenloch, fewer car miles will be generated and thus operating costs will be lower. Capital costs will also be reduced because fewer rail cars will be required.

CHAPTER 5

OPERATING AND COST CHARACTERISTICS

OPERATING AND COST CHARACTERISTICS

TRANSIT RUNNING TIMES

The following describes the criteria used in establishing the running times of the proposed Cross County Service Alternatives including connecting services. The running times were used to establish inter-zonal transit travel times in the Modal Split model and in the calculation of operating and capital costs.

Regional Rail Alternative

The station to station running times were established using a train performance simulation model that took into account line grades, curvature, station stops and the performance characteristics of the vehicles. The simulation was performed for service between Downingtown and Trenton. Total cycle times accounted for switching and turning trains at Downingtown and Trenton including crew layover and also included an allowance for delays associated with interfacing with Amtrak and other SEPTA trains between Downingtown and Glenloch and between Morrisville and Trenton. When ridership projections suggested cutting the west end of the service back at Glenloch, the cycle times were adjusted to eliminate the running time between Glenloch and Downingtown and delays associated with interfacing with Amtrak and other SEPTA trains in that segment. The operation is based on providing passing sidings for meets at line speeds.

Model Vehicle:	Silverliner IV
Maximum Line Speed:	80 mph
Station Dwell Time:	30 seconds

Light Rail Alternative

The Light Rail alternative provides a trunk line service between Glenloch and Morrisville via Norristown. The station to station running times were established using a train performance simulation model that took into account line grades, curvature, station stops and the performance characteristics of the vehicles. Total cycle times account for turning trains at Glenloch and Morrisville including crew layover and includes an allowance for delays associated with interfacing with existing Norristown High Speed Line trains between Hughes Park and Norristown. The operation is based on providing passing sidings for meets at line speeds.

Model Vehicle:	N5 Light Rail Vehicle
Maximum Line Speed:	80 mph
Station Dwell Time:	30 seconds

Busway Alternative

The Busway alternative consists of two services: One is a trunk line express service between Glenloch and Morrisville with local extension over existing roads to the Exton Mall and Exton R5 station at the west end and to Trenton at the east end. The other is a local service between the Great Valley Corporate Center and Oxford Valley Mall that uses portions of the busway and diverts over existing roads through major office parks and transportation centers. The running times on the busway are based on accelerating to a maximum speed of 55 mph and braking for station stops without interference of other traffic. Running times over local portions of the route are based on the existing average speeds of SEPTA routes operating over the same roads or nearby roads and include an allowance for access to and from the busway. Total cycle time is based on layovers equal to 10% of the round trip running time with a minimum of 5 minutes.

Maximum Line Speed (on busway):	55 mph

Average Acceleration (on busway):	0.85 mph/sec
Average Deceleration (on busway):	2 mph/sec
Station Dwell Time (on busway):	20 seconds
Average Speed over local roads:	Varies
Dwell Time at Transportation Centers:	3 minutes
Average Busway Access Time:	30 seconds

Improved Bus Alternative

The Improved Bus alternative provides a trunk line service between Exton Mall on the west and Oxford Valley Mall on the east. The service consists of express portions over segments of US Route 202 and the Pennsylvania Turnpike, and local portions over existing roads serving major office parks and transportation centers. The express portion running times are based on estimated average speeds over US Route 202, the turnpike access roads, and on the turnpike main road. The turnpike access roads consist of the route extending from the ramps as they merge or diverge from the main roadway, through the toll booth area, and to the intersection with the local highway. The average speed through the turnpike access area is based on assumed TSM improvements which will permit busses to bypass toll booths and related queues without delay and to have expedited access onto the local highway. The local portion running times are based on the average speed of existing SEPTA routes on the same roads or nearby roads. Total cycle times include a layover equal to 10% of the round trip running time with a minimum of 5 minutes.

Average Speed on Turnpike:	50 mph
Average Turnpike Access Speed:	30 mph
Average US Route 202 Speed:	40 mph
Average Speed on Local Roads:	Varies
Dwell Time at Transportation Centers:	3 minutes

Exhibit 5-1
Cross County Metro Feasibility Assessment
SEPTA FY 1992 Operating Costs By Expense Category

	Vehicle Operations	Vehicle Maintenance	Nonvehicle Maintenance	General & Administrative	Headquarter Allocation	Total
City Transit Division						
Trolley Bus	$6,421,343	$2,030,326	$1,006,060	$1,356,878	$1,416,300	$12,230,907
Surface Rail	$24,383,581	$11,321,609	$7,726,637	$7,931,364	$4,317,300	$55,680,491
Bus	$111,132,782	$42,671,363	$14,339,497	$40,009,988	$27,425,100	$235,578,730
High Speed Rail	$44,060,213	$17,921,997	$30,329,538	$6,261,827	$27,274,700	$125,848,275
Subtotal City Transit	**$185,997,919**	**$73,945,295**	**$53,401,732**	**$55,560,057**	**$60,433,400**	**$429,338,403**
Suburban Transit Division						
Surface Rail	$2,634,951	$1,105,848	$1,180,501	$103,516	$506,000	$5,530,816
Bus	$17,979,858	$5,191,247	$1,451,429	$2,451,269	$4,225,574	$31,299,377
High Speed Rail	$2,756,842	$1,589,486	$1,527,401	$356,548	$1,114,129	$7,344,406
Subtotal Suburban Transit	**$23,371,651**	**$7,886,581**	**$4,159,331**	**$2,911,333**	**$5,845,703**	**$44,174,599**
Regional Rail Division *						
Commuter Rail	$31,189,144	$27,854,744	$48,827,078	$55,238,504	$1,381,692	$164,491,162
Total Operating Cost	**$240,558,714**	**$109,686,620**	**$106,388,141**	**$113,709,894**	**$67,660,795**	**$638,004,164**

Source: SEPTA, National Bureau Of Labor Statistics

* - Operating costs are inflated from FY 1991 using Urban CPI index of 4.2%. FY 1992 actual operating costs were not used due to Railworks project.

have had an atypical effect on the estimation of commuter rail costs for the Cross County Corridor. Instead, FY 1991 operating cost and service statistics which precede the Railworks project and represent more typical operating conditions and service for this regional commuter rail system were used. The FY 1991 cost experience was then inflated to represent FY 1992 cost experience based on the Urban Consumer Price Index which corresponded to the overall cost inflation experienced by SEPTA. The resulting operating costs of the proposed alternatives will be estimated based on the service levels and resources required to operate the existing SEPTA mass transit system.

Selection Of Representative Service

SEPTA is a large and diversified transit system composed of several different modes of service including bus, light rail, heavy rail, commuter rail, trolley bus and paratransit. The proposed alternative services for the Cross County Metro service include bus, light rail, regional rail and busway operations. SEPTA currently operates similar service in these areas except for the busway mode. Specific transit service modes as classified by SEPTA were selected to match the various types of service proposed for the Cross County Corridor.

The Frontier Bus System was selected from the Suburban Transit Division to be the representative service in terms of operating costs and characteristics because it operates in this same suburban environment and has similar physical characteristics to the additional bus services proposed along the Cross County Corridor.

The Busway alternative will be represented by the Frontier Bus System with additional incremental costs included for the maintenance and operation of the Busway stations and structures. The Busway itself is a capital structure and does not require much in the way of operating and maintenance costs. These incremental costs will be estimated from the cost experience of transit systems with existing busways and adapted to the labor and fringe cost experienced at SEPTA. The operating and maintenance costs of the actual

CHAPTER 5

OPERATING AND COST CHARACTERISTICS

OPERATING AND COST CHARACTERISTICS

TRANSIT RUNNING TIMES

The following describes the criteria used in establishing the running times of the proposed Cross County Service Alternatives including connecting services. The running times were used to establish inter-zonal transit travel times in the Modal Split model and in the calculation of operating and capital costs.

Regional Rail Alternative

The station to station running times were established using a train performance simulation model that took into account line grades, curvature, station stops and the performance characteristics of the vehicles. The simulation was performed for service between Downingtown and Trenton. Total cycle times accounted for switching and turning trains at Downingtown and Trenton including crew layover and also included an allowance for delays associated with interfacing with Amtrak and other SEPTA trains between Downingtown and Glenloch and between Morrisville and Trenton. When ridership projections suggested cutting the west end of the service back at Glenloch, the cycle times were adjusted to eliminate the running time between Glenloch and Downingtown and delays associated with interfacing with Amtrak and other SEPTA trains in that segment. The operation is based on providing passing sidings for meets at line speeds.

Model Vehicle:	Silverliner IV
Maximum Line Speed:	80 mph
Station Dwell Time:	30 seconds

Light Rail Alternative

The Light Rail alternative provides a trunk line service between Glenloch and Morrisville via Norristown. The station to station running times were established using a train performance simulation model that took into account line grades, curvature, station stops and the performance characteristics of the vehicles. Total cycle times account for turning trains at Glenloch and Morrisville including crew layover and includes an allowance for delays associated with interfacing with existing Norristown High Speed Line trains between Hughes Park and Norristown. The operation is based on providing passing sidings for meets at line speeds.

Model Vehicle:	N5 Light Rail Vehicle
Maximum Line Speed:	80 mph
Station Dwell Time:	30 seconds

Busway Alternative

The Busway alternative consists of two services: One is a trunk line express service between Glenloch and Morrisville with local extension over existing roads to the Exton Mall and Exton R5 station at the west end and to Trenton at the east end. The other is a local service between the Great Valley Corporate Center and Oxford Valley Mall that uses portions of the busway and diverts over existing roads through major office parks and transportation centers. The running times on the busway are based on accelerating to a maximum speed of 55 mph and braking for station stops without interference of other traffic. Running times over local portions of the route are based on the existing average speeds of SEPTA routes operating over the same roads or nearby roads and include an allowance for access to and from the busway. Total cycle time is based on layovers equal to 10% of the round trip running time with a minimum of 5 minutes.

Maximum Line Speed (on busway):	55 mph

Average Acceleration (on busway): 0.85 mph/sec
Average Deceleration (on busway): 2 mph/sec
Station Dwell Time (on busway): 20 seconds
Average Speed over local roads: Varies
Dwell Time at Transportation Centers: 3 minutes
Average Busway Access Time: 30 seconds

Improved Bus Alternative

The Improved Bus alternative provides a trunk line service between Exton Mall on the west and Oxford Valley Mall on the east. The service consists of express portions over segments of US Route 202 and the Pennsylvania Turnpike, and local portions over existing roads serving major office parks and transportation centers. The express portion running times are based on estimated average speeds over US Route 202, the turnpike access roads, and on the turnpike main road. The turnpike access roads consist of the route extending from the ramps as they merge or diverge from the main roadway, through the toll booth area, and to the intersection with the local highway. The average speed through the turnpike access area is based on assumed TSM improvements which will permit busses to bypass toll booths and related queues without delay and to have expedited access onto the local highway. The local portion running times are based on the average speed of existing SEPTA routes on the same roads or nearby roads. Total cycle times include a layover equal to 10% of the round trip running time with a minimum of 5 minutes.

Average Speed on Turnpike: 50 mph
Average Turnpike Access Speed: 30 mph
Average US Route 202 Speed: 40 mph
Average Speed on Local Roads: Varies
Dwell Time at Transportation Centers: 3 minutes

Connecting Services

Connecting Services consist of existing bus routes which intersect the corridor and proposed new shuttle services serving selected corridor stations. The running times of proposed shuttle services are based on the average speeds attained by existing SEPTA routes using the same roads or nearby roads. Where appropriate the running times and total cycle times of existing intersecting routes have been increased to account for time required to serve the Cross County stations and for where routes have been extended or diverted to serve a station. Station service times are estimated based on the assumption that buses at most stations will pull into the station and stop adjacent to the platform. This estimate varies according to the location of each station. Total cycle times include a layover equal to 10% of the round trip running time with a minimum of 5 minutes.

OPERATING AND MAINTENANCE COSTS

One important criterion in assessing the merits or drawbacks of each particular alternative is the recurring annual operating and maintenance costs. A reliable estimate of the costs of operating and maintaining each transit alternative is crucial to an accurate assessment of its cost effectiveness and financial feasibility. These costs are based on the unique staffing, scheduling and material requirements associated with each alternative's modal configuration, level of service and operational philosophy presently organized by SEPTA. In this way, the overall economic analysis will be sufficiently broad to encompass both the expected initial capital costing outlay, and also the likely annual operating and maintenance costs.

The operating cost estimation process for the Cross County Metro Feasibility Assessment employed a cost allocation modeling approach. This methodology calculates operating costs as a function of the resource levels necessary to operate each corridor alternative. The resource levels are measured in terms of vehicle miles, vehicle hours, peak vehicles and track miles. The operating costs are based on the existing management center expense categories used by SEPTA in the operation of these same modes and services. A unit cost per resource level is then calculated for each unit of service used in each alternative. The alternative operating plans specify the resource levels of service and these unit cost measures are combined to result in the calculation of operating costs. The calculation of reliable cost estimates for operating and maintenance expenses is thereby sensitive to both the varying physical characteristics of each proposed alternative and the specific operational conditions encountered by SEPTA.

The cost allocation model was developed by identifying and relating operating costs to service levels and then calculating the unit cost per that level of service. This approach computes costs by examining operating budget line items of the labor and materials needed to provide a given level of service and then applying projected unit costs of labor and material to the selected alternatives. The sources used for the operating cost detail are the detail operating budget estimates for each budget line or management center throughout the SEPTA organization. The management center costs are assigned to a particular service resource level measure based on known relationships between the cost functions and the service functions.

The sensitivity of the operating and maintenance costing methodology can be enhanced through the development of unit costs specific to the most relevant portion of the SEPTA operation. It is beneficial to utilize similar modal types of service and operational conditions when calculating unit costs of specific alternatives. The costing approach employed goes one step further to also select the most appropriate existing transit services operated by SEPTA to best represent the proposed alternatives for the Cross County Metro service. The overall organizational costs are then included in a subsequent step and at a summary level of detail to adequately allocate the expected full operating costs as appropriate to each alternative.

It should be noted that the cost allocation model is developed on the basis of overall system and operating and financial statistics, and for this reason is not intended to respond to all unique situations at a detailed level. In addition this technique is not intended to be used as a budgeting tool, where resources and expenditures by cost centers are analyzed and projected at a very detailed level. However, the cost allocation technique is well suited for the current feasibility assessment to investigate the operating cost consequences of various transit options. The model is capable of providing reliable operating cost estimates for individual alternatives in a consistent framework and is recommended for this use by the Federal Transit Administration.

Existing Transit System

The SEPTA mass transit system serves Philadelphia and the four surrounding counties with an integrated network of approximately one hundred thirty bus, trackless trolley, light rail, rapid rail and commuter rail services, plus region wide paratransit services. The SEPTA system consists of three service divisions:

- City Transit Division - Operates primarily within the City of Philadelphia with route extensions into suburban Central Bucks, Eastern Montgomery and Delaware Counties. This service includes bus, light rail, trackless trolley and subway/elevated modes for a total of one hundred thirty routes over 885 route miles and carrying over 250 million unlinked passengers per year or almost one million passengers per average weekday throughout the city of Philadelphia.

- Suburban Transit Division - Operates in the surrounding Counties of Bucks, Chester, Delaware and Montgomery. This division is composed of the Red Arrow service and the Frontier Bus service combined. This service operates 19 bus and 3 light rail routes over 325 route miles transporting over 14 million unlinked passengers per year.

- Regional Rail Division - Operates seven regional commuter rail routes over 282 route miles and 486 track miles to one hundred sixty-two active stations throughout the five county Southeastern Pennsylvania Region. Service is also provided to Trenton and West Trenton, New Jersey and Wilmington, Delaware with parking available at most stations. This division operates 340 rail vehicles with 263 operated during the peak period. This service transports 21,240,000 unlinked passengers per year or an average of 74,000 passengers per weekday with an average trip distance of 14.6 miles.

The organization of SEPTA around these three divisions has been used to focus the estimation of operating and maintenance costs for the four Cross County Corridor alternatives. SEPTA suburban bus operating cost experience has been used to estimate the suburban bus operating costs within the corridor. Suburban light rail costs have been estimated from the cost experience of operating the Norristown High Speed Line. Regional rail cost estimation has been based on the overall cost experience of operating the Regional Rail Division.

The total annual operating costs for these SEPTA divisions are presented in Exhibit 5-1 by general expense category and mode. The City Transit Division had a total operating cost of $429 million in fiscal year (FY) 1992 accounting for 67% of the total. Operating costs for the Suburban Transit Division were $44 million and for Regional Rail, $165 million, for a total of $638 million for the entire SEPTA system. These figures are presented to demonstrate the starting point from which the operating and maintenance cost estimation analysis is based.

Operating costs for each proposed alternative are built up from these actual operating costs provided by SEPTA. The only exception was that fiscal year 1992 operating costs could not be used for the Regional Rail Division due to the Railworks project which affected the normal scheduling and productivity of its operations. These conditions would

Exhibit 5-1
Cross County Metro Feasibility Assessment
SEPTA FY 1992 Operating Costs By Expense Category

	Vehicle Operations	Vehicle Maintenance	Nonvehicle Maintenance	General & Administrative	Headquarter Allocation	Total
City Transit Division						
Trolley Bus	$6,421,343	$2,030,326	$1,006,060	$1,356,878	$1,416,300	$12,230,907
Surface Rail	$24,383,581	$11,321,609	$7,726,637	$7,931,364	$4,317,300	$55,680,491
Bus	$111,132,782	$42,671,363	$14,339,497	$40,009,988	$27,425,100	$235,578,730
High Speed Rail	$44,060,213	$17,921,997	$30,329,538	$6,261,827	$27,274,700	$125,848,275
Subtotal City Transit	**$185,997,919**	**$73,945,295**	**$53,401,732**	**$55,560,057**	**$60,433,400**	**$429,338,403**
Suburban Transit Division						
Surface Rail	$2,634,951	$1,105,848	$1,180,501	$103,516	$506,000	$5,530,816
Bus	$17,979,858	$5,191,247	$1,451,429	$2,451,269	$4,225,574	$31,299,377
High Speed Rail	$2,756,842	$1,589,486	$1,527,401	$356,548	$1,114,129	$7,344,406
Subtotal Suburban Transit	**$23,371,651**	**$7,886,581**	**$4,159,331**	**$2,911,333**	**$5,845,703**	**$44,174,599**
Regional Rail Division *						
Commuter Rail	$31,189,144	$27,854,744	$48,827,078	$55,238,504	$1,381,692	$164,491,162
Total Operating Cost	**$240,558,714**	**$109,686,620**	**$106,388,141**	**$113,709,894**	**$67,660,795**	**$638,004,164**

Source: SEPTA, National Bureau Of Labor Statistics

* - Operating costs are inflated from FY 1991 using Urban CPI index of 4.2%. FY 1992 actual operating costs were not used due to Railworks project.

have had an atypical effect on the estimation of commuter rail costs for the Cross County Corridor. Instead, FY 1991 operating cost and service statistics which precede the Railworks project and represent more typical operating conditions and service for this regional commuter rail system were used. The FY 1991 cost experience was then inflated to represent FY 1992 cost experience based on the Urban Consumer Price Index which corresponded to the overall cost inflation experienced by SEPTA. The resulting operating costs of the proposed alternatives will be estimated based on the service levels and resources required to operate the existing SEPTA mass transit system.

Selection Of Representative Service

SEPTA is a large and diversified transit system composed of several different modes of service including bus, light rail, heavy rail, commuter rail, trolley bus and paratransit. The proposed alternative services for the Cross County Metro service include bus, light rail, regional rail and busway operations. SEPTA currently operates similar service in these areas except for the busway mode. Specific transit service modes as classified by SEPTA were selected to match the various types of service proposed for the Cross County Corridor.

The Frontier Bus System was selected from the Suburban Transit Division to be the representative service in terms of operating costs and characteristics because it operates in this same suburban environment and has similar physical characteristics to the additional bus services proposed along the Cross County Corridor.

The Busway alternative will be represented by the Frontier Bus System with additional incremental costs included for the maintenance and operation of the Busway stations and structures. The Busway itself is a capital structure and does not require much in the way of operating and maintenance costs. These incremental costs will be estimated from the cost experience of transit systems with existing busways and adapted to the labor and fringe cost experienced at SEPTA. The operating and maintenance costs of the actual bus services that travel over the busway is similar to other suburban bus service. The Frontier Bus System is a suburban bus service, and as such, represents the most logical choice to provide the basis for estimating the bus operating costs over a busway.

SEPTA's Norristown High Speed Line has been selected to represent the Light Rail alternative because it is their most comparable light rail service with higher speeds and longer station spacing than other SEPTA light rail services. The FY 1992 operating budget for the Norristown High Speed Line has been selected for light rail cost projections. The Norristown High Speed Line is the best match for a proposed light rail line because it would be very similar to the light rail technology and service being examined for the Cross County Corridor.

The Regional Rail Division is the representative selection for the proposed Regional Rail alternative. The entire regional rail system of SEPTA was included to provide the basis for the operating cost analysis for the commuter rail alternative because the joint use of lines, support facilities and staff combine to an overall regional cost experience of the regional rail lines rather than an individual representative line. All information relating to the Regional Rail Division is based on FY 1991 operating costs and service and has been escalated using the Urban Consumer Price Index.

Allocation Model Conceptual Basis

The primary underlying premise of the cost allocation model is that each individual line item expense account can be represented by one or more of the service levels of the transit system. The operating costs for those proposed Cross County Corridor alternatives are based on two different cost models, a three variable cost allocation model for bus and light rail and a seven variable model for regional rail. These cost allocation methods have already been accepted, utilized and applied by SEPTA's Planning Department for their "Dallas 92 Report." This report is used by SEPTA as an internal costing and service evaluation modeling system to present an accurate reflection of how individual transit routes compare to one another on a unit cost basis. A detailed explanation of the cost model and derivation of operating and maintenance costs for each alternatives is included in Appendix M of the separate Technical Appendix.

Alternative Operating and Maintenance Costs

The cost models developed for each alternative were applied to each alternative to estimate the related operating and maintenance costs. Exhibit 5-2 lists each of the specified alternatives and their associated incremental operating costs in relation to the baseline alternative. The resulting operating and maintenance costs are based on the operating plans developed for each alternative. Each of the alternatives is estimated as an increment over the Baseline or existing bus service that currently operates through the Cross County Corridor. It is also important to recognize that the operating and maintenance costs for each alternative are estimated as the incremental change in the total operating and maintenance costs. For example, since SEPTA already operates a service similar to each of the proposed alternatives, additional headquarters staff costs were not included.

Exhibit 5-2

ALTERNATIVE OPERATING AND MAINTENANCE COSTS

Alternative	Total Cost	Incremental Cost	% Change From Baseline
Baseline (existing service)	$40,594,503		
Improved Bus	$45,710,361	$5,115,858	12.60%
Busway	$46,319,061	$5,724,558	14.10%
Light Rail	$47,687,914	$7,093,411	17.47%
Regional Rail	$61,491,910	$20,897,407	51.48%

Urban Engineers, Inc. 1993

The following operating and maintenance costs represent a reasonable estimate to operate each alternative type of service within the SEPTA operating and financial conditions.

- Baseline (Existing Service) - The baseline alternative represents service in the Cross County Corridor with no variations. It includes each bus route that intersects the corridor from both the Suburban and City Transit Divisions (See Appendix 2). The intersecting routes were determined from the schematic diagrams developed for each of the proposed alternatives. The total operating and maintenance costs for this baseline alternative are $40.6 million annually. This total cost will serve as the baseline or existing operating and maintenance costs from which to estimate the incremental change of each additional alternative.

- Improved Bus - This alternative includes the Baseline service plus one route from Exton Station to Oxford Valley Mall through the Cross County corridor and new shuttle service on bus Route 95 in addition to the existing service. The total operating and maintenance costs for this alternative are $5.1 million, 12.6% higher than the baseline. This alternative represents the optimization of the baseline scenario or existing service and provides the basis for comparison in the Cost Effectiveness Analysis as discussed in Chapter 8.

- Busway - This alternative includes a combination of the baseline service with adjustments to several routes and the addition of a trunk and branched busway service through the corridor. The trunk service will operate from Glenloch to Morrisville as an exclusive on-busway service; branched busway service will operate in addition to the trunk line. The proposed busway service combined with the changes in several existing routes to accommodate the new service will cost $5.7 million or 14.1% over the baseline in annual operating and maintenance costs. In addition to holding headquarters administrative costs constant, articulated buses were examined to provide further reductions in operating and maintenance costs by decreasing bus hours, miles and peak vehicles. It was determined that operating and maintenance costs could be decreased but the articulated buses would not be able to accommodate the ridership levels for this alternative, therefore peak vehicles could not be reduced to a level which would justify the costs of articulated vehicles. The operating costs were estimated based on the suburban bus cost model with an additional increase to the vehicle mile unit cost to account for operation and maintenance of the busway. The operating and maintenance cost basis was obtained from the Minnesota Department of Transportation for a similar fixed guideway system on a per vehicle mile basis.

- Light Rail - The light rail alternative includes the Baseline service with adjustments to several of the routes to accommodate this new service. The light rail alternative will provide service from Glenloch to Morrisville. The segment from Downingtown to Glenloch was not included in this alternative because of the high level of operating costs due to accessing Amtrak tracks. In addition, estimated ridership was not large enough to justify operation of this segment. This alternative also includes new service in the form of two local bus shuttles from Chesterbrook Station to Chesterbrook Corporate Center and Valley Forge station to Valley Forge Executive Mall. The combined incremental operating and maintenance costs for this alternative excluding additional headquarters costs are $7.1 million annually, 17.5% above the Baseline service. These costs are based on the use of articulated light rail vehicles with one man crews throughout the day. The use of higher technology, articulated vehicles reduces operating and maintenance costs significantly by decreasing annual vehicle miles, hours and decreasing peak vehicle requirements by 50% while providing the necessary capacity.

- Regional Rail - The regional rail alternative includes the Baseline service with adjustments to several of the routes to accommodate the new service. Regional rail will operate service beginning at Glenloch on the west end through the Cross County corridor to Trenton. This alternative also includes new service in the form of two local bus shuttles from Chesterbrook Station to Chesterbrook

Corporate Center and Valley Forge station to Valley Forge Executive Mall. The combined incremental operating and maintenance costs for this alternative are $20.9 million annually which is 51.5 % above the Baseline service. (The Regional Rail alternative was originally defined to operate to Downingtown. When low ridership projections for the west end of the service prompted cutting back the service to Glenloch, it was noted that the shorter version of the service would save approximately $7.5 million in annual operating and maintenance costs).

CAPITAL COSTS

The capital costs for the four Cross County Metro alternatives are based on unit prices applied against estimated quantities. The unit prices are derived from various sources. The quantities are based on estimates and assumptions as described in detail below for each of the four alternatives.

All costs are expressed in 1993 dollars. The annualized capital costs are derived by multiplying the total capital costs by the standard capital recovery factor using a discount or interest rate of 7 per cent and an economic life for each element in accordance with FTA guidelines. The construction cost elements are grouped into six categories as described below:

- Guideway Elements
- Systems
- Stations
- Yards and Shops
- Vehicles
- Right-of-Way

In addition, costs related to engineering and management of the project as well as contingencies are included. A description of each alternative and the capital cost assumptions associated with each alternative are discussed below.

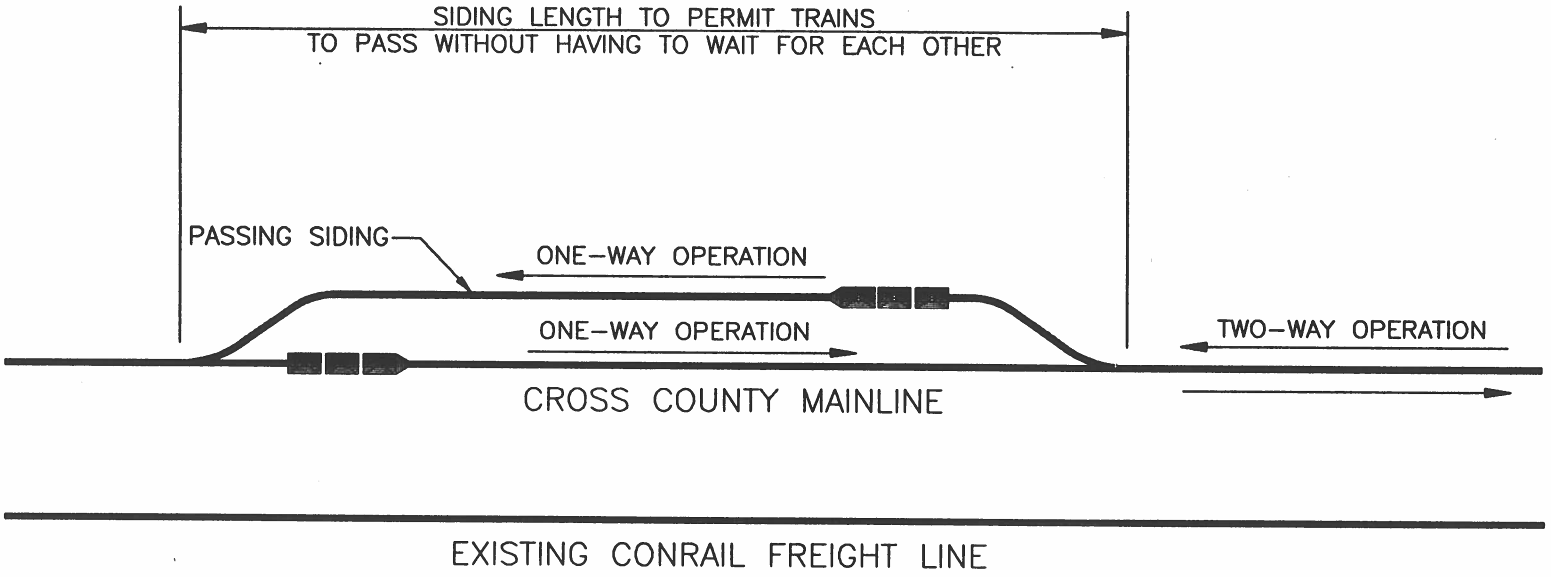
Regional Rail

The Regional Rail alternative would operate between Downingtown in Chester County and Trenton in Mercer County. Between Downingtown and Glenloch, a distance of 7 miles, and Morrisville and Trenton, a distance of 1.6 miles, the service would operate on existing Amtrak lines which carry SEPTA rail service. It is assumed that no capital investments would be required for these segments.

Between Glenloch and Morrisville, a distance of 46.4 miles, the service would operate on Conrail's Morrisville line right-of-way. This is primarily a double track right-of-way on which one track has been removed. The Cross County service would operate primarily on a single track re-constructed in the line of the track that was removed. An additional track would need to be constructed to accommodate required passing sidings. Exhibit 5-3 shows a typical arrangement for a passing siding schematically. In most cases this additional track would require new right-of-way construction including earthwork, retaining walls, and alteration or expansion of bridges.

The capital cost estimate is based on providing a total of eight passing sidings, the locations of which were determined by simulation to be required to support 15 minute peak period headways. The passing sidings would each be two miles in length and have number 20 turnouts so as to accommodate scheduled running meets wherein trains could pass each other at line speeds.

- Guideway: Most of the Retained fill/cut, and bridge costs are associated with accommodating the passing sidings. It is assumed that 80% of the


SIDING LENGTH TO PERMIT TRAINS
TO PASS WITHOUT HAVING TO WAIT FOR EACH OTHER
PASSING SIDING
ONE-WAY OPERATION
ONE-WAY OPERATION
TWO-WAY OPERATION
CROSS COUNTY MAINLINE
EXISTING CONRAIL FREIGHT LINE

Urban Engineers, Inc.
300 N. 3rd Street
Philadelphia, PA 19106-1193

Cross County Metro

PASSING SIDING CONFIGURATION

EXHIBIT 5-3

length of the passing sidings will require construction of retaining walls. Within the passing siding areas it is assumed that 25% of the overhead bridges would have to have an additional span constructed to provide clearance for the additional track and that a further 25% of the bridges would have be demolished and replaced to provide clearance for the additional track. It is assumed that all undergrade structures in the passing siding areas would require a new span to carry the additional track but that the sidings would be located to avoid alteration of major bridges such as those over the Schuylkill River and the Neshaminy Creek.

- Systems: The Morrisville line was previously electrified, and most of the catenary structures remain. West of Ernest, the catenary structures consist of two poles with a cross span support arrangement spanning the space of two tracks. These poles presently carry active Amtrak transmission lines. Construction of a single track in the line of the track that was removed will allow these structures to be re-used almost as-is. Where an additional track is required for a passing siding, the passing track could be constructed outside of the existing poles, but the back guys would have to be removed. It is expected that these structures would need to be altered with addition of a cross beam.

  East of Ernest the catenary structures consist of a single pole with a two track bracket arm. The single pole carries a transmission line. In part of this segment the transmission line is out of service. In another part of this segment, the transmission line is a new PECO line which was recently placed into service. The PECO project eliminated a few catenary structures and introduced some guy wires that may have to be modified. It is expected that the structures throughout the PECO section will have to be modified for the re-introduction of a catenary system. In the areas where passing sidings are required, additional alterations will be required.

East of Ernest there are two substations that have been abandoned. These, as well as the substation at Ernest, will have to be re-equipped to supply 25 cycle power to the catenary system. Because a new PECO line has replaced much of the former transmission line, and new 25 cycle transmission line may be required.

The cost estimate allows for a new signal system for 80 mph operation including cab signals. In addition to the passing sidings, the signal system would provide interlocked access to Amtrak's Harrisburg line at Glenloch. At Morrisville, an existing interlocking provides access to Amtrak's Northeast Corridor. The junction at Morrisville is arranged such that Cross County trains would enter on the inside tracks and have to interface with Amtrak high speed traffic in order to reach the outside tracks generally used by SEPTA trains. This arrangement will subject Cross County trains to additional delays. A revised junction arrangement would be very expensive to construct and is not included in the cost.

- Stations: A Morrisville Station that would allow transfer to SEPTA's R7 trains would have to be located within the area of the grade separated junction with Amtrak's Northeast Corridor and will present major design difficulties. Expensive structures will be required to provide access between the Cross County platforms and the R7 tracks which are widely separated at this location. Transferring passengers would have to cross above or below Amtrak's high speed tracks.

  The Ernest Station will have to be located on the bridge over the Schuylkill River in order to permit transfers to the R6 line beneath the bridge at a substantially lower elevation. Special structural costs will be incurred at this location.

- Vehicles: It is assumed that the Regional Rail vehicles will be similar to the existing Silverliner IV fleet. Although the projected peak ridership could be accommodated on a single car (maximum of 89 persons per train), problems associated with the interface with Amtrak's signal system at each end of the route require that trains have a minimum of two cars; therefore, car requirements are based on two-car trains. The regional rail service was originally assumed to operate to Downingtown. When low ridership projections for the west end of the service prompted the service to be cut back to Glenloch, it was noted that capital costs would be reduced because the shorter cycle times reduced the required number of rail vehicles from 34 to 28.

Light Rail

The Light Rail alternative would operate between Glenloch and Morrisville. Between Glenloch and Hughes Park and between a point east of Ernest and Morrisville, the service would operate via Conrail's Morrisville line. In these segments, like the Regional Rail alternative, the service would operate on a single track in the line of the track that was removed. Between Hughes Park and Norristown the service would operate on the existing Norristown High Speed Line. Between Norristown and a point east of Ernest, the service would operate on the right-of-way of Conrail's Ford Street Connection track.

The capital cost estimate is based on providing a total of seven passing sidings that would be needed to support 15 minute peak period headways. Like the regional rail alternative, each of these sidings would be two miles in length and designed to accommodate running meets.

- Guideway: On the Morrisville line right-of-way, the Light Rail alternative will require essentially the same type of investments as the Regional Rail alternative. Retained fill/cut and bridge work would mostly be required to accommodate the passing sidings. The same assumptions as the Regional Rail alternative were used to estimate these costs.

At Hughes Park, an underpass will be required to facilitate a track providing connection to the Norristown High Speed Line. The underpass would be beneath a Conrail track. In Norristown, a structure will be required to accommodate a track that would diverge from the existing NHSL tracks, curve southward, and descend to grade. The structure will have to accommodate an additional elevated platform at the station.

- Systems: In order to be compatible for operation on the Norristown High Speed Line, the Light Rail alternative would operate at 650 volts DC. It is assumed that the cars for the Cross County service would be equipped with both 3rd rail shoes (for operation on the Norristown High Speed Line) and pantographs (for operation on the Morrisville Line and Ford Street Connection track rights-of-way).

Reuse of existing catenary structures along the Morrisville Line would involve the same issues and similar costs as the Regional Rail alternative. New structures would be required along the Ford Street Connection track. Traction power supply would be via 36 small substations that would be powered from local PECO services. No transmission lines would be required.

The Light Rail alternative would be equipped with a signal system similar to the Regional Rail alternative but modified to be compatible with operation on the Norristown High Speed Line. It would be designed for 80 mph maximum speeds. In addition to the 7 passing sidings, a new interlocking would be required at the junction with the Norristown High

Speed Line at Hughes Park. This junction would consist of a turnout and a crossover. There would be no connection to Amtrak at either end of the line.

- Stations: The Morrisville Station would be located on the bridge structure carrying Conrail's Fairless Steel connection over Amtrak's Northeast Corridor. The platform would be located on a structure adjacent to or cantilevered from the bridge in the space where the Amtrak tracks are widely separated. Walkways (on new structure or cantilevered on the existing structure) would provide access over the high speed and local tracks to new platforms along the local tracks.

  The Norristown Station would require a new elevated platform.

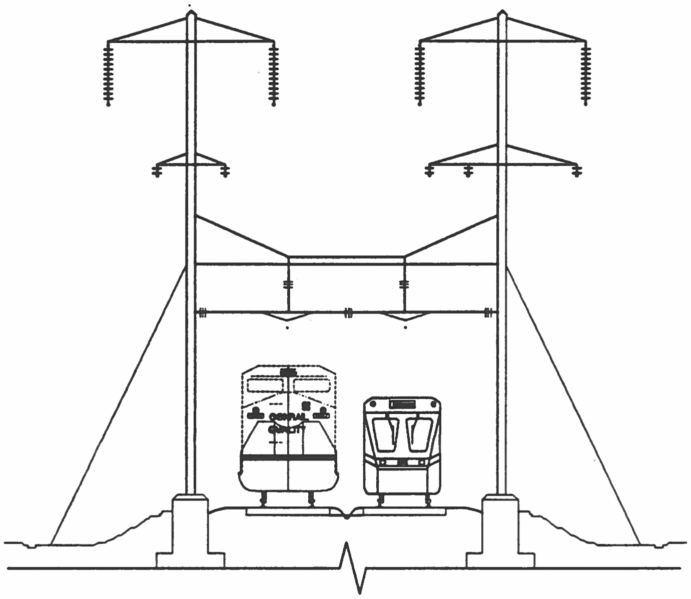
- Vehicles: It was originally assumed that the vehicles for the Light Rail Alternative would be similar to the new N5 cars on the Norristown High Speed Line except that the cars would be equipped with pantographs in addition to third rail shoes. Estimated peak loads of 80 persons per train suggested that peak hour trains would have to consist of two of the 60 seat cars, and, per SEPTA operating practice, require two employees on peak hour trains; therefore, larger capacity articulated light rail vehicles were selected for estimating capital costs. This reduced the required number of rail vehicles by 50 per cent and would allow all trains to operate with a single employee.

Busway

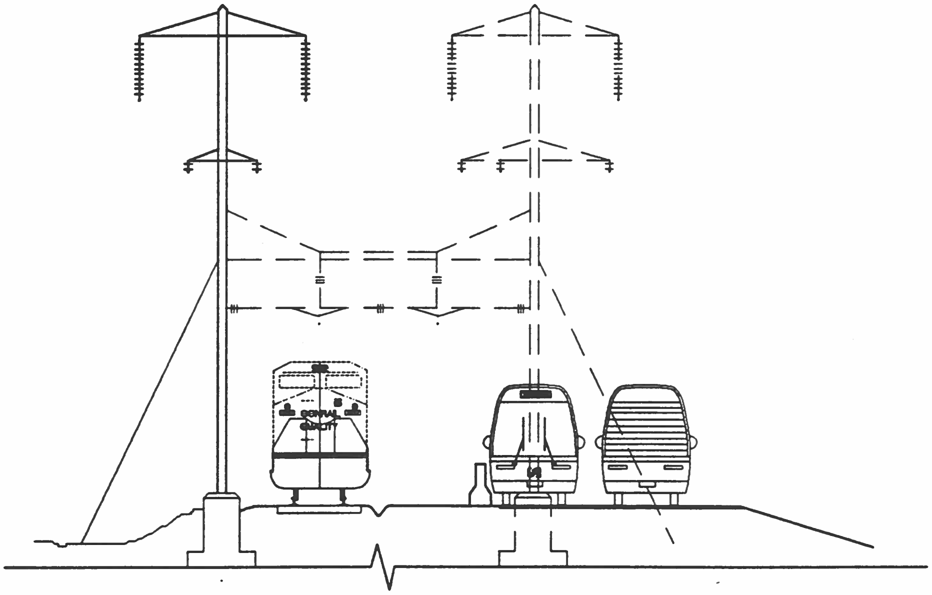
The busway would be constructed along Conrail's Morrisville line from Glenloch to Morrisville. The Busway would consist of two 12 foot lanes with 2 foot shoulders on each side. There would be a concrete barrier between the Conrail track and the adjacent busway. It is assumed that 12 feet of clearance would be required between the barrier and the center line of Conrail's track.

- Guideway: Unlike the Regional Rail and Light Rail alternatives, the dimensional and clearance requirements of the Busway will not permit it to make convenient use of the space previously occupied by a track. Most of the length of the Morrisville line roadbed will need to be substantially widened. The difference between the Busway and Rail alternatives in their ability to make use of the Morrisville line right-of-way is illustrated in Exhibit 5-4. The greater space requirements of the Busway will generate substantial costs for both retained cut/fill and bridge work. It was assumed that 70 % of the length of the busway will require construction of retaining walls. It is assumed that one third of all overhead bridges will require the addition of a span to accommodate the busway beneath and one third will require demolition and re-construction. It is assumed that 80% of all undergrade bridge locations will have to have new two-lane busway structures including the major bridges over the Schuylkill River and Neshaminy Creek. The remaining locations will require alterations to the existing bridge and addition of a single lane structure.

- Systems: The Busway will not require an electrification system, but it will have a major impact on the existing structures and transmission lines. West of Ernest one pole of the existing two-pole structures will have to be removed and the remaining structure altered. One of the Amtrak transmission lines will have to be relocated onto the remaining poles, with substantial modifications, or onto new structures. In some locations east of Ernest, the existing single pole catenary structures will have to be removed. This includes the segment with the new PECO transmission line.



REGIONAL RAIL OR LIGHT RAIL



BUSWAY

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300 N. 3rd Street
Philadelphia, PA 19106-1193

Cross County Metro

RAIL & BUSWAY
OCCUPATION OF
MORRISVILLE LINE
RIGHT-OF-WAY

Exhibit
5-4

Improved Bus

The Improved Bus service will operate on portions of existing US Route 202 and the Pennsylvania Turnpike as well as other streets and highways.

- Guideway: Guideway capital costs for the Improved Bus alternative are limited to Transportation Systems Management (TSM) Improvements. Because TSM improvements are difficult to justify on suburban highways with small bus volumes, and because the size of the corridor does not permit detailed analysis of individual locations within the scope of the study, the only TSM improvements identified and used in the operating plan for the Improved Bus alternative are measures to expedite bus movements through Turnpike interchanges. It is assumed that these improvements would include an additional ramp or lane for buses over most of the path through the toll area including a special toll gate or bypass for buses that would not require buses to stop. It would also include provisions for expediting access from the turnpike to the local highway.

The total estimated capital costs and their annualized equivalent are summarized on Exhibit 5-5. Detailed tabulations of capital costs are in Appendix E of the separate Technical Appendix.

Exhibit 5-5
CROSS COUNTY METRO
CAPITAL COST SUMMARY

	REGIONAL RAIL		LIGHT RAIL		BUSWAY		IMPROVED BUS	
COST CATEGORY	CAPITAL COST (000'S)	ANNUAL COST (000'S)	COST (000'S)	ANNUAL COST (000'S)	COST (000'S)	ANNUAL COST (000'S)	COST (000'S)	ANNUAL COST (000'S)
GUIDEWAY ELEMENTS:	105,680	8,484	101,012	8,110	260,545	22,506	1,150	109
SYSTEMS:	77,173	6,218	80,270	6,469	8,960	722	0	0
STATIONS:	17,570	1,463	15,582	1,300	24,676	2,025	0	0
YARDS AND SHOPS:	1,460	117	2,085	168	2,337	188	1,360	110
VEHICLES:	51,675	4,570	25,092	2,273	7,055	888	6,314	795
RIGHT-OF-WAY:	5,665	397	5,541	388	6,885	482	0	0
SOFT COSTS:	43,517	3,554	39,912	3,245	55,942	4,828	1,059	117
CONTINGENCY:	90,822	7,436	80,845	6,570	109,920	9,479	2,966	342
TOTAL:	393,561	32,239	350,338	28,523	476,320	41,118	12,849	1,473

Urban Engineers, Inc. , 1993

CHAPTER 6

ESTIMATION OF RIDERSHIP

ESTIMATION OF RIDERSHIP

INTRODUCTION

This chapter documents the travel demand forecasting methodology and results. The chapter begins with a discussion of the file updates completed prior to development of a mode choice model. A description of the mode choice model is then provided, followed by a presentation of mode choice model validation results. The final section of the chapter presents ridership forecasts for each of the study alternatives.

Prior to developing a mode choice model for calibration, the following three tasks had to be completed:

- Development of socioeconomic databases
- Development of person trip tables
- Update of transit network files

After the above-noted databases and files were updated, a mode choice model was developed. The model used for this study is a derivation of a model used in the Maryland Statewide Commuter Assistance Study. Transit trip tables developed from the mode choice model were then validated, followed by a validation of the assignment to a transit network.

For this study, 1987 and 2015 person trip tables (Home-Based Work, Home-Based Other and Non Home-Based), transit network files and highway skim files were obtained from the Delaware Valley Regional Planning Commission (DVRPC). In addition, 1987, 1990, 2010 and 2015 socioeconomic data bases were provided by the DVRPC. Person trip tables were then developed for 1990 (the calibration year) and 2010 (the forecast year)

- Home-Based Other Attraction Factors

  The DVRPC trip generation model estimates HBO trip attractions on the basis of each TAZ's households, basic employment, retail employment and other employment. These same variables were used in this study's fratar process, with the same variable weights as used by the DVRPC.

- Non Home-Based Production and Attraction Factors

  The DVRPC trip generation model estimates NHB trip productions and attractions on the basis of households, basic employment, retail employment and other employment. These same variables were used in this study's fratar process, with the same weights as used by the DVRPC.

1990 Person Trip Results

The fratar model went through four iterations of matching trip productions with trip attractions, with approximately 95 percent of the model's 4th iteration growth factors being within 5 percent of the desired growth factors. It is important to note that this person trip table does not include trips from Burlington, Camden and Gloucester Counties, nor does it include external trips (i.e. the table does not include trips that extend beyond the study boundaries). Overall, 1990 total trips are 4.5 percent higher than 1987 total trips, as shown in Exhibit 6-1.

Appendix F of the separate Technical Appendix presents 1990 person trip tables for each trip purpose, by the DVPRC's county planning districts (TAZ's aggregated into districts).

Exhibit 6-1

COMPARISON OF 1987 AND 1990 PERSON TRIPS

Year	HBW	HBO	NHB	Total
1987	5,705,244	12,200,178	5,195,410	23,100,832
1990	5,883,372	12,857,768	5,405,894	24,147,034
Difference	178,128	657,590	210,484	1,046,202
% Change	3.1%	5.4%	4.1%	4.5%

Manuel Padron & Associates, 1993

2010 Person Trip Results

The fratar model was also used to develop 2010 person trip tables from DVRPC 2015 trip tables. Similarly to 1990 data, approximately 95 percent of the model's 4th iteration growth factors were within 5 percent of the desired growth factors. It is important to note that this person trip table also does not include trips from Burlington, Camden and Gloucester Counties, nor does it include external trips. Overall, 2010 total trips are 5.5 percent lower than 2015 DVRPC total trips, as shown in Exhibit 6-2.

Exhibit 6-2

COMPARISON OF 2010 AND 2015 PERSON TRIPS

Year	HBW	HBO	NHB	Total
2015	6,711,186	14,908,470	6,215,196	27,834,852
2010	6,635,966	13,737,332	5,940,222	26,313,520
Difference	-75,220	-1,171,138	-274,974	-1,521,332
% Change	-1.1%	-7.9%	-4.4%	-5.5%

Manuel Padron & Associates, 1993

Appendix G of the separate Technical Appendix presents 2010 person trip tables for each trip purpose, by the DVPRC's county planning districts (TAZ's aggregated into districts). The fratared estimate of 2010 person trips is 9.0 percent higher than the fratared estimate of 1990 person trips.

Travel Patterns Analysis

Travel patterns within the study corridor were analyzed by evaluating trip distributions for the following DVRPC planning areas:

County	District	Description
Chester	19	Upper Main Line (Tredyffrin)
	22	Downingtown
Montgomery	30	Upper Eastern (Upper Moreland)
	35	Norristown Area
Bucks	49	Middletown
Mercer	52	Trenton

Figures provided in Appendix H of the separate Technical Appendix graphically illustrate the portion of HBW, HBO and NHB trips that are remaining within the specified planning district, remaining within the study corridor, and traveling to/from Philadelphia. Generally, trips between Philadelphia and the selected planning districts were more likely to be HBW trips.

Person Trip Table Validation

Distributions reflected in the 1990 HBW person trip table were verified by making a comparison to 1990 Journey-to-Work Census data. Comparisons were limited to counties that comprise the study area (Bucks, Chester, Montgomery and Mercer). As shown in Exhibit 6-3, the model is adequately replicating the number of HBW trips produced in the four counties. It is also replicating distributions of HBW trips from the four counties to other counties.

TRANSIT NETWORKS

Transit networks used for this study were developed from 1987 and 2015 regional transit networks provided by the DVRPC. In order to complete a 1990 validation, the 1987 network was updated to reflect 1990 transit service levels. The 2015 network also was modified to reflect proposed service levels for each alternative. This section of the report presents a brief description of the network modifications that were completed.

1990 Network

The SEPTA regional rail system reflected in the DVRPC 1990 network was modified to reflect 1991 rail schedules provided by SEPTA (1990 rail schedules were not available). A comparison of the coded 1987 rail network to the 1991 schedules indicates that significant changes have occurred with regards to routing, headways and skip stops. As an example, the 1987 network reflects operation of an R-1 line from West Trenton to the 30th Street Station, and operation of an R-3 line from Elwyn to the N. Broad Station. The 1991 schedules indicates that R-3 service was modified, providing service from Elwyn to West Trenton via downtown Philadelphia. The R-1 line was reassigned to service between downtown Philadelphia and the Airport.

The regional rail line network was re-coded to reflect 1991 a.m. peak period schedules. Appendix I of the Technical Appendix presents the new regional rail lines. Thirty-nine separate rail train operations were coded to reflect a.m. peak period service on the seven regional rail lines. Skip stops were reflected in the coding.

Exhibit 6-3

SEPTA CROSS COUNTY CORRIDOR FEASIBILITY STUDY VALIDATION OF HBW PERSON TRIP DISTRIBUTIONS

1. VALIDATION OF TOTAL HBW TRIPS

HBW Trips Produced In:	% of Regional Trips	
	Model	'90 Census
Bucks County	14.5%	14.4%
Chester County	10.2%	10.0%
Montgomery County	18.9%	19.2%
Mercer County	8.5%	7.4%

2. VALIDATION OF HBW TRIP DISTRIBUTION

HBW Trips From:	HBW Trips To:	Model	'90 Census
Bucks County	Bucks County	59.4%	60.2%
	Chester County	0.5%	0.8%
	Montgomery County	18.2%	16.6%
	Mercer County	6.7%	9.6%
	Philadelphia County	14.4%	12.1%

HBW Trips From:	HBW Trips To:	Model	'90 Census
Chester County	Bucks County	0.4%	0.6%
	Chester County	69.4%	67.6%
	Montgomery County	14.4%	14.5%
	Mercer County	0.1%	0.1%
	Philadelphia County	4.7%	6.7%

HBW Trips From:	HBW Trips To:	Model	'90 Census
Montgomery County	Bucks County	6.9%	6.2%
	Chester County	5.1%	5.3%
	Montgomery County	64.6%	68.3%
	Mercer County	0.2%	0.3%
	Philadelphia County	18.4%	16.6%

HBW Trips From:	HBW Trips To:	Model	'90 Census
Mercer County	Bucks County	3.3%	2.3%
	Chester County	0.1%	0.1%
	Montgomery County	0.5%	0.4%
	Mercer County	94.9%	96.2%
	Philadelphia County	1.2%	0.9%

Manuel Padron & Associates 1993

The DVRPC transit network was also reviewed to determine changes in bus service within the study's 10-mile wide corridor. Approximately 25 SEPTA bus routes operate within the corridor. 1990/91 schedules and route maps were used to update the DVRPC 1987 transit network. New routes added to the network include: #95, 201, 205 and 130. Routes #45 and #133 were eliminated, and several routes were modified reflecting changes in street routings. Appendix I of the separate Technical Appendix presents a listing of modifications completed to the 1987 DVRPC bus route network.

2010 Base Network

A 2010 base transit network was developed from the DVRPC's 2015 transit network. The DVRPC network reflects a number of regional transit improvements that are included in the region's long range transportation plan. Therefore, the 2015 network was used to represent the 2010 network, with minor modifications. Appendix I of the separate Technical Appendix lists the network line cards that reflect the 2010 Base Network regional rail system. Bus lines were modified to reflect service improvements that were made to the 1990 network. Those modifications are also listed in Appendix I.

2010 Networks for Study Alternatives

The 2010 base transit network was then modified for each of this study's transit alternatives. Four alternative networks were coded: Improved Bus, Busway, Light Rail, and Regional Rail transit. Following is a brief description of each alternative network (refer to Chapters 4 and 5 for a detailed description of the study alternatives).

- Improved Bus

  A new bus line was coded from Exton Mall to Oxford Valley Mall via US 202, the Pennsylvania Turnpike and US 1. Peak period headways were coded at 15 minutes, base period headways were coded at 30 minutes. This new bus line would be connected to other SEPTA bus and regional rail lines at various locations. Peak period service would be increased on Route #95 from 60 minute headways to 15 minute headways.

- Busway

Two new bus lines were coded for the Busway alternative. The first line would provide trunk line service from Exton Mall to Trenton. Peak period headways were coded at 15 minutes and base period headways were coded at 60 minutes. A second line would operate along the busway for a portion of the route, but also would provide local service to major developments along the busway, such as Great Valley Corporate Center and Oxford Valley Mall. This line also would have 15 minute peak period and 60 minute base period headways. Headways would be improved on Route #95, and routing on select bus lines would be modified to improve transfers between local routes and the busway line haul route. Busway stations are listed below:

Exton Mall
Glenloch
Great Valley
Chesterbrook
Valley Forge
Warner Road
King of Prussia
Hughes Park
Ernest
Plymouth Meeting
Fort Washington
Dresher
Willow Grove
Heaton
Feasterville
Woodbourne
Morrisville
Trenton

- Light Rail Transit

This alternative reflects a new light rail line from Glenloch to Morrisville, with service through Norristown. Peak period headways were coded at 15 minutes and base period headways were coded at 60 minutes. In addition, headways would be improved on connecting bus routes #206, #201 and #210 and routing for select bus lines would be modified to improve transfers. New shuttle bus routes are added to the Chesterbrook Corporate Center, Valley Forge Executive Mall and the Swedeland Corporate Center. Stations along the light rail line are as follows:

Glenloch
Great Valley
Chesterbrook
Valley Forge
Warner Road
King of Prussia
King Manor
Bridgeport
Norristown
Plymouth Meeting
Fort Washington
Dresher
Willow Grove
Heaton
Feasterville
Woodbourne
Morrisville

- Regional Rail

This alternative reflects a new regional rail line from Downington to Trenton. Peak period headways were coded at 15 minutes and base headways were coded at 60 minutes. Headways would be improved on connecting routes #206, #201 and #210. In addition, routing for select lines were modified. New shuttle bus routes were added to the Chesterbrook Corporate Center, Valley Forge Executive Mall and the Swedeland Corporate Center. Stations along the new regional rail line are as follows:

Downingtown
Whitford
Exton
Glenloch
Great Valley
Chesterbrook
Valley Forge
Warner Road
King of Prussia
Hughes Park
Ernest
Plymouth Meeting
Fort Washington
Dresher
Willow Grove
Heaton
Feasterville
Woodbourne
Morrisville
Trenton

MODEL CALIBRATION

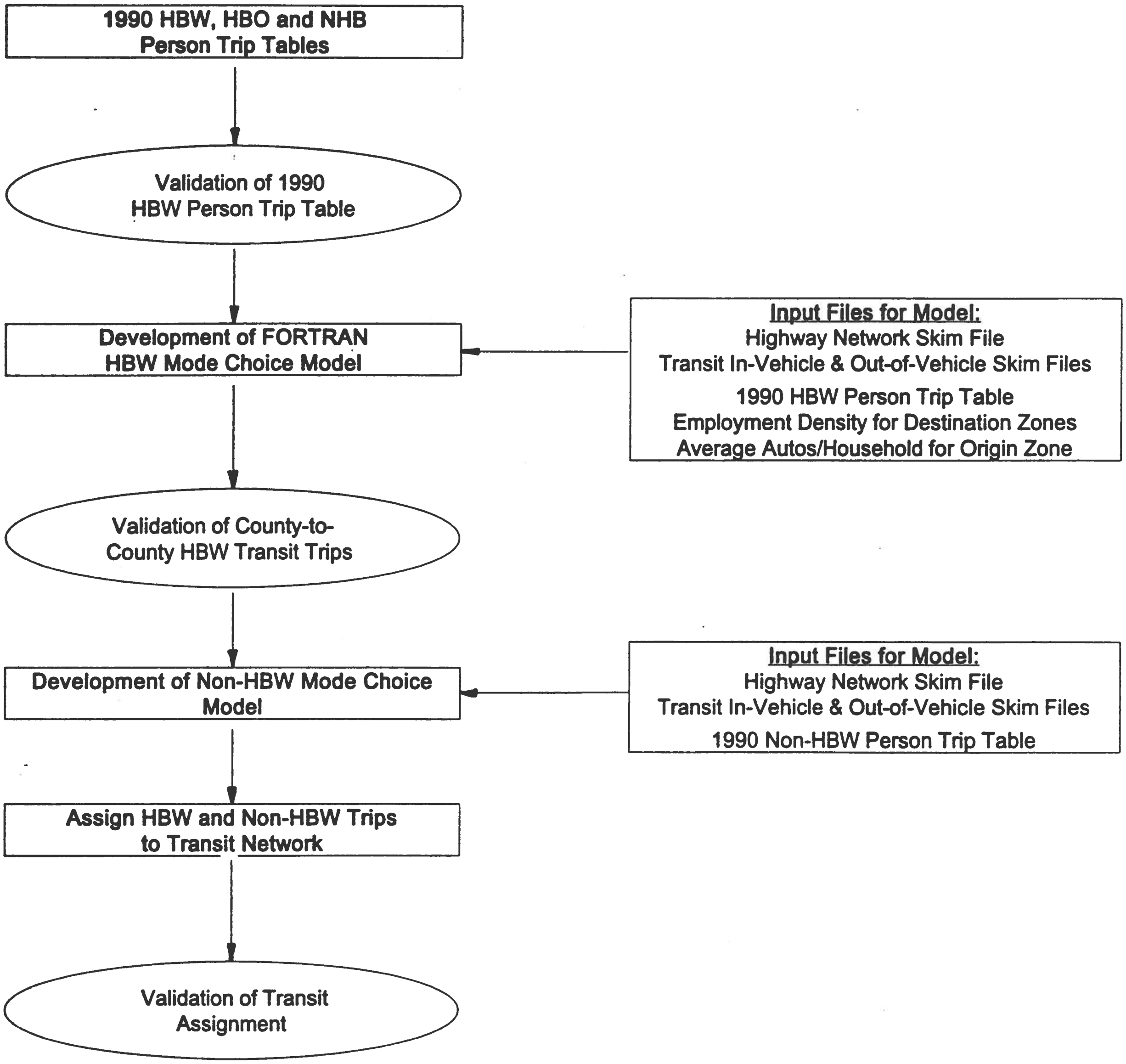
This section of the report presents the mode choice calibration process completed for this study. First, the calibration process is described. The mode choice equation and associated variables and coefficients are then presented. Validation results are then noted for the model's estimate of HBW transit trips and the total transit trip assignment.

Description of Calibration Process

The mode choice model used for this study is a derivation of a mode choice model used for the *Maryland Statewide Commuter Assistance Study*. The Maryland model uses zone-to-zone person trip matrices, highway time and distance matrices, and transit in-vehicle and out-of-vehicle travel time matrices. Highway and transit times are converted to modal dis-utilities, which are used in a binomial logit formulation (highway/transit). Exhibit 6-4 presents the general model development and calibration process for this study.

Exhibit 6-4

SEPTA CROSS COUNTY CORRIDOR FEASIBILITY STUDY FLOW CHART OF MODEL CALIBRATION PROCESS


1990 HBW, HBO and NHB Person Trip Tables
Validation of 1990 HBW Person Trip Table
Development of FORTRAN HBW Mode Choice Model
Input Files for Model:
Highway Network Skim File
Transit In-Vehicle & Out-of-Vehicle Skim Files
1990 HBW Person Trip Table
Employment Density for Destination Zones
Average Autos/Household for Origin Zone
Validation of County-to-County HBW Transit Trips
Development of Non-HBW Mode Choice Model
Input Files for Model:
Highway Network Skim File
Transit In-Vehicle & Out-of-Vehicle Skim Files
1990 Non-HBW Person Trip Table
Assign HBW and Non-HBW Trips to Transit Network
Validation of Transit Assignment

Manuel Padron & Associates 1993

The program used is capable of reading TranPlan person trip tables and network travel time files. Transit and highway utiles were initially determined from equations used in the Maryland mode choice model. Variations of the Maryland transit utile equations were then developed to test the impact of additional variables on HBW transit trips. In order to improve sensitivity of the mode choice model, two new variables were introduced to the equation: employment density and average autos per household. As is noted later in this section, application of these two variables resulted in a better simulation of HBW transit trip distributions. The final step in the calibration process was an assignment of transit trips to a 1990 transit network. HBW transit trips and non-HBW transit trips were assigned to the transit network, and then added together. The assignment was validated by comparing the model's estimate of total unlinked transit trips to actual unlinked transit trips, by mode. In addition, the model's estimate of individual regional rail line trips were compared to actual rail line trips.

Mode Choice Model Development

The transit share for each zone-to-zone trip interchange is determined by the following equation:

$$\text{Transit Share} = \text{Exp.}(\text{Transit Utile})/(\text{Exp.}(\text{Transit Utile})+\text{Exp.}(\text{Highway Utile}))$$

The transit and highway utiles determine the likelihood that a trip will be made by either mode. The highway utile used in the Maryland study, as well as in this study is based on the following equation:

$$\text{Highway Utile} = (-0.0173)\ \ (\text{In-Vehicle Time})$$

The primary coefficients and variables used in the transit utile equation for the Maryland study were:

$$\text{Transit Utile} = (-0.0583)\ (\text{Out-of-Vehicle Time}) - (0.0173)\ (\text{In-Vehicle Time})$$

Thus, out-of-vehicle wait times are given higher consideration over in-vehicle travel times by a factor of 3.37. This equation was initially tested for this study, and was found to incorrectly distribute HBW transit trips within the region. The model was overestimating suburb-to-suburb trips and underestimating suburb-to-downtown trips. Therefore, two new variables were added to the equation. A variable representing average autos per household was added to better distribute transit trip productions. A second variable representing employment densities was added to better distribute transit trip attractions. Both variables were normalized by relating TAZ data to regional average data. The employment factor was weighted in order to give employment density a comparable weight to the average autos per household factor.

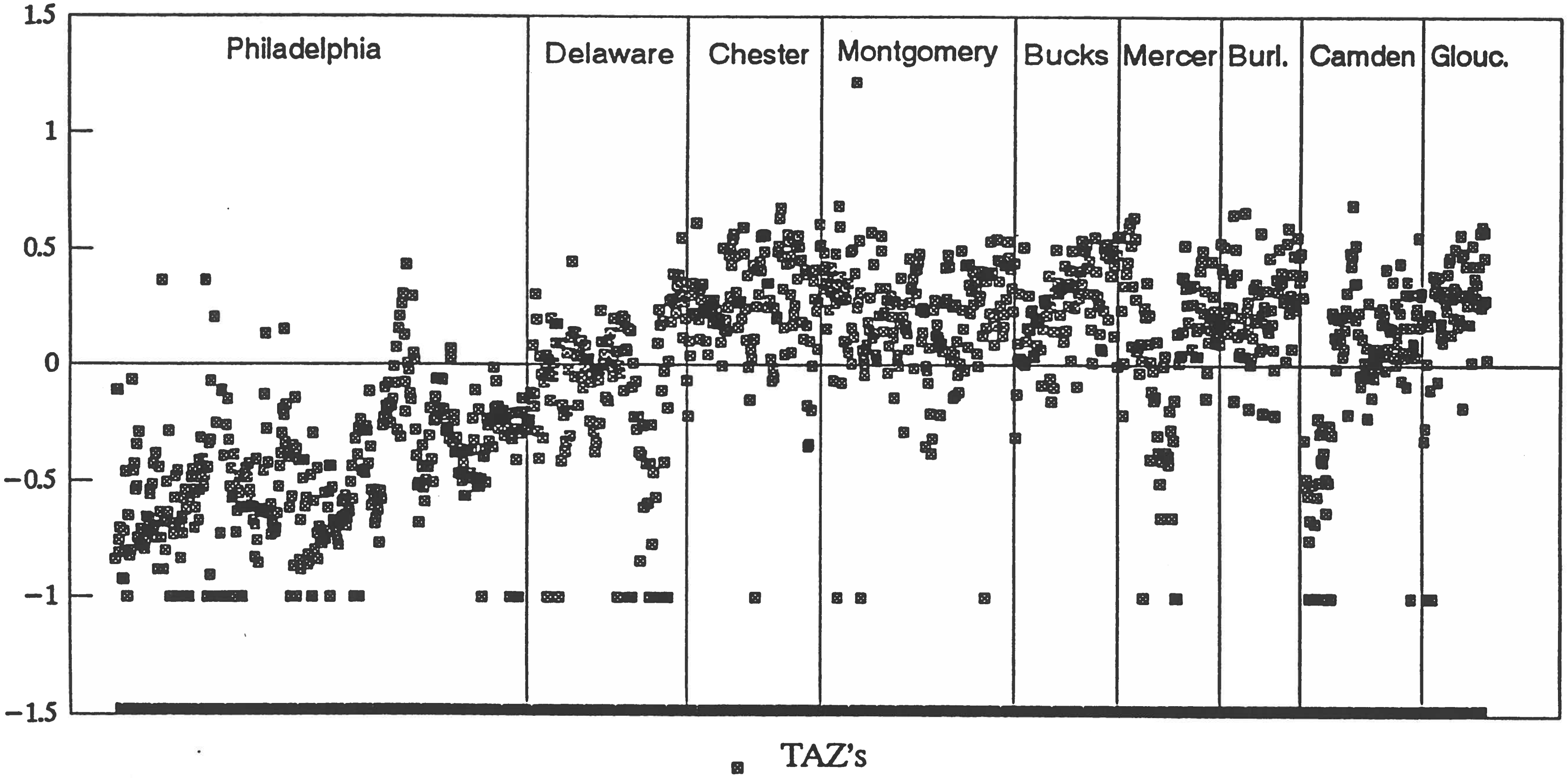
Exhibits 6-5 and 6-6 present plots of the TAZ average autos per household and employment density factors. Exhibit 6-5 illustrates that auto ownership is generally below the regional average in Philadelphia, and above the regional average in suburban counties. Exhibit 6-6 illustrates that employment densities are highest in the Philadelphia Center City TAZ's.

Application of the auto ownership and employment density factors was found to generate a much better simulation of HBW transit trips. Specific county-to-county area factors were then applied to the model, for better simulation of geographic travel patterns. Thus, the final transit utile equation used for this study is as follows:

$$\begin{aligned}\text{Transit Utile} = {} & (-0.0583)\ (\text{Out-of-Vehicle Time}) - (0.0173)\ (\text{In-Vehicle Time}) \\ & + \text{Autos/HH Factor} + \text{Empl. Density Factor} + \text{Area Factor}\end{aligned}$$

Exhibit 6-5

SEPTA CROSS COUNTY METRO FEASIBILITY STUDY
PLOT OF AVERAGE AUTOS PER HOUSEHOLD FACTOR

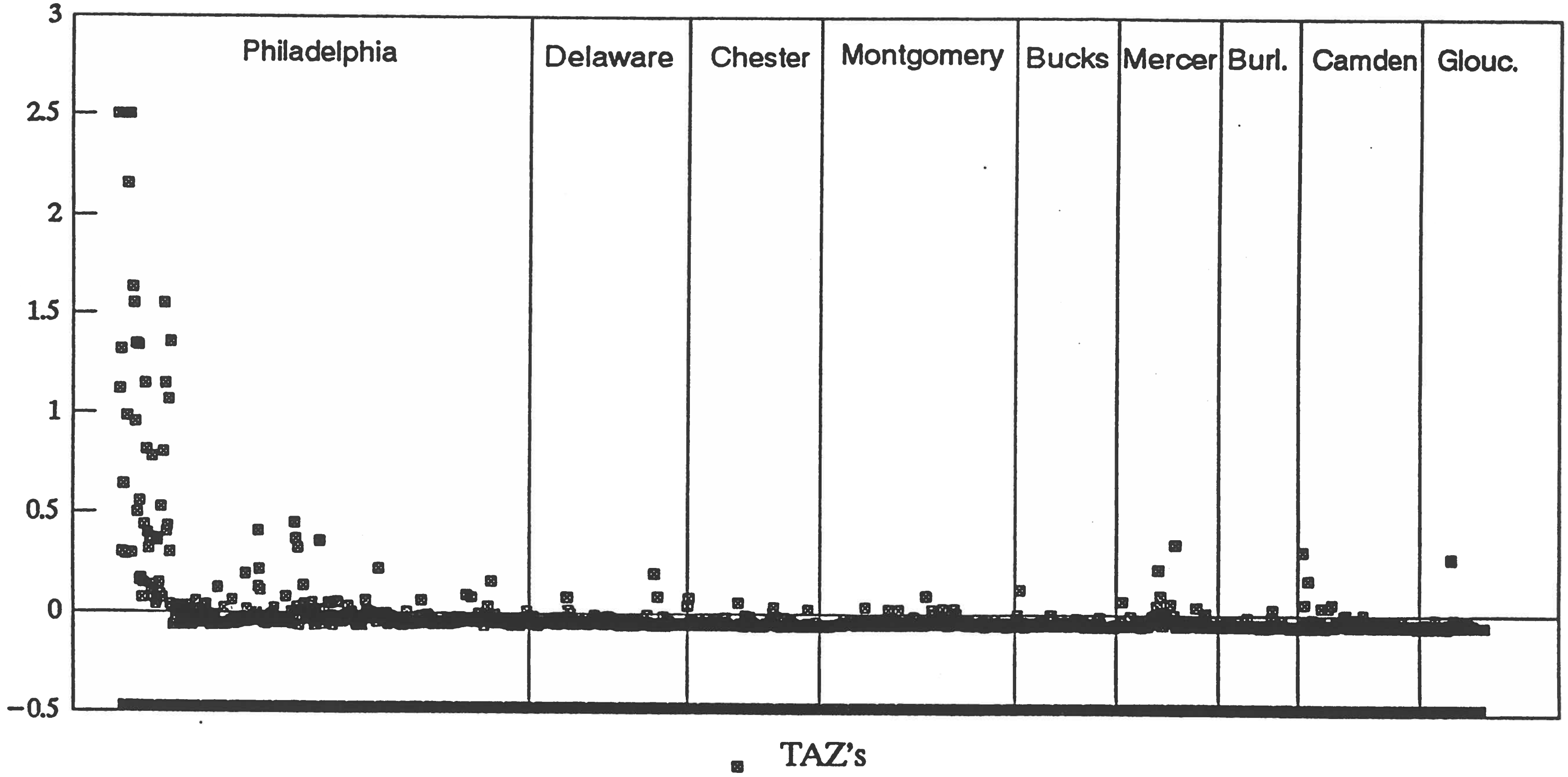


Note: Average autos per household factors shown in plot have been normalized.

MANUEL PADRON & ASSOCIATES, 1993

Exhibit 6-6

SEPTA CROSS COUNTY METRO FEASIBILITY STUDY
PLOT OF EMPLOYMENT DENSITY FACTORS



Note: Average employment density factors shown in plot have been normalized.

MANUEL PADRON & ASSOCIATES, 1993

Mode Choice Validation Results

The revised mode choice equation was applied to the 1990 HBW person trip table to obtain an estimate of 1990 HBW transit trips. This estimate was then compared to 1990 Census Journey-to-Work data and DVRPC model calibration data for 1987. A comparison of model HBW transit trips to actual HBW transit trips is provided in Exhibit 6-7. As noted in this table, the model is estimating 454,588 daily transit trips. Journey-to-work data indicates that there are approximately 471,740 daily HBW transit trips, representing a 16 percent transit mode split for total HBW person trips in the six-county study area.

Non-HBW transit trips were then estimated by applying the mode choice model to the non-HBW person trip table. First wait times and transit-to-transit transfer wait times were factored by two to reflect off-peak first wait and transfer wait times. (An off-peak transit network was not available from the DVRPC.) The model generated an estimate of 301,529 non-HBW transit trips. When added to HBW transit trips, total system ridership (linked trips) is estimated at 756,118. SEPTA's average daily linked ridership in 1990 was 784,400. Thus, the model underestimates total linked transit trips by 3.6 percent.

The model program is listed in Appendix J of the separate Technical Appendix.

RIDERSHIP RESULTS

Transit ridership was estimated for the baseline (no improvement) system and the four study alternatives (Improved Bus, Busway, Light Rail, Regional Rail) in the forecast year 2010. The first section presents regional daily HBW, Non-HBW and total ridership for each alternative. The second section presents ridership activity on the busway, light rail transit and regional rail lines.

Exhibit 6-7

COMPARISON OF MODEL AND ACTUAL HBW TRANSIT TRIPS

HBW Trips from:	Model Estimate	Actual Estimate *	Difference	Percent Difference
Philadelphia	360,010	372,388	(12,378)	-3.32%
Delaware	40,972	42,001	(1,029)	-2.45%
Chester	3,315	3,811	(496)	-13.01%
Montgomery	30,633	33,170	(2,537)	-7.65%
Bucks	7,607	7,918	(311)	-3.93%
Mercer	12,051	12,451	(400)	-3.21%
TOTAL	454,588	471,739	(17,151)	-3.64%

HBW Trips to:	Model Estimate	Actual Estimate *	Difference	Percent Difference
Philadelphia	380,835	382,451	(1,616)	-0.42%
Delaware	36,820	45,536	(8,716)	-19.14%
Chester	2,836	4,136	(1,300)	-31.43%
Montgomery	16,730	21,017	(4,287)	-20.40%
Bucks	5,677	7,046	(1,369)	-19.43%
Mercer	11,690	11,553	137	1.19%
TOTAL	454,588	471,739	(17,151)	-3.64%

* = Actual estimate based on DVRPC estimate of HBW transit trips and 1990 Journey-to-Work Census Data.

Prepared by: Manuel Padron & Associates 1993

Daily System Ridership

The mode choice models (HBW and Non-HBW) were run for the baseline (no improvement) regional transit system. The baseline system was estimated to generate 821,589 daily linked transit trips, 65,471 (8.7%) more than the 1990 calibration year. The ridership growth results from increased population (+8.5%) and employment (+13.9%) as well as transit improvements included in the 2010 transit network. Almost 68% of the ridership growth between 1990 and 2010 would be HBW trips (44,328), which represents an increase of 9.8%. Non-HBW trips were estimated to increase by 21,144, or 7.0%. The transit mode share (i.e., percent transit) for the six county region would be 15.0% for HBW trips, 3.3% for Non-HBW trips, and 6.2% for all trips. These mode shares represent a slight decrease from 1990 transit ridership (which reflects increasing auto ownership and population and employment growth in suburban rather than urban areas). The mode choice models (HBW and non-HBW) were also run for the transit system including each of the four study alternatives (Improved Bus, Busway, Light Rail, Regional Rail). This produced total daily linked transit trips for the six county region in the 2010 forecast year with each of the study alternatives in place. New transit ridership generated by each alternative, estimated by comparing the total transit ridership with each alternative to the total baseline transit ridership, is presented in Exhibit 6-8.

Exhibit 6-8

ESTIMATED TRANSIT RIDERSHIP

Alternative	New Transit Riders	Percent HBW Trips	Percent Non-HBW Trips
Improved Bus	1,324	45%	55%
Busway	5,587	36%	64%
Light Rail	9,106	32%	68%
Regional Rail	9,963	34%	66%

Urban Engineers, Inc. 1993

Line Loads

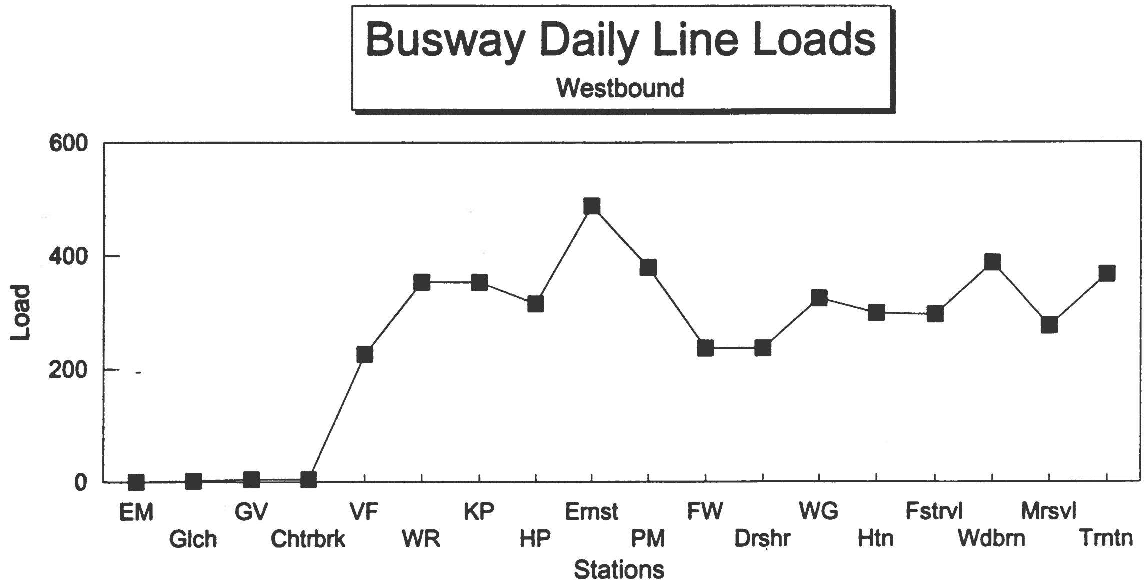
The daily HBW and Non-HBW transit trips were then assigned to the transit networks for the Busway, Light Rail and Regional Rail alternatives. The total riders that board the busway, light rail and regional rail lines include new transit riders generated by the improved level of service as well as riders diverted from other transit lines. The assignment model determined the line loading or the number of riders using each segment between stations.

For the Busway alternative, peak hour ridership was estimated to be about 15% of the daily ridership, based on SEPTA's current ridership peaking characteristics for the bus operations (*Ridership and Statistics Report Fiscal Year 1991*). Exhibit 6-9 shows the estimated daily line loads for the Busway alternative (eastbound and westbound, respectively).

Peak hour ridership for the Light Rail alternative was estimated to be about 19% of the daily ridership, based on SEPTA's current ridership peaking characteristics for the regional rail mode. Exhibit 6-10 shows the estimated daily line loads for the Light Rail alternative (eastbound and westbound, respectively).

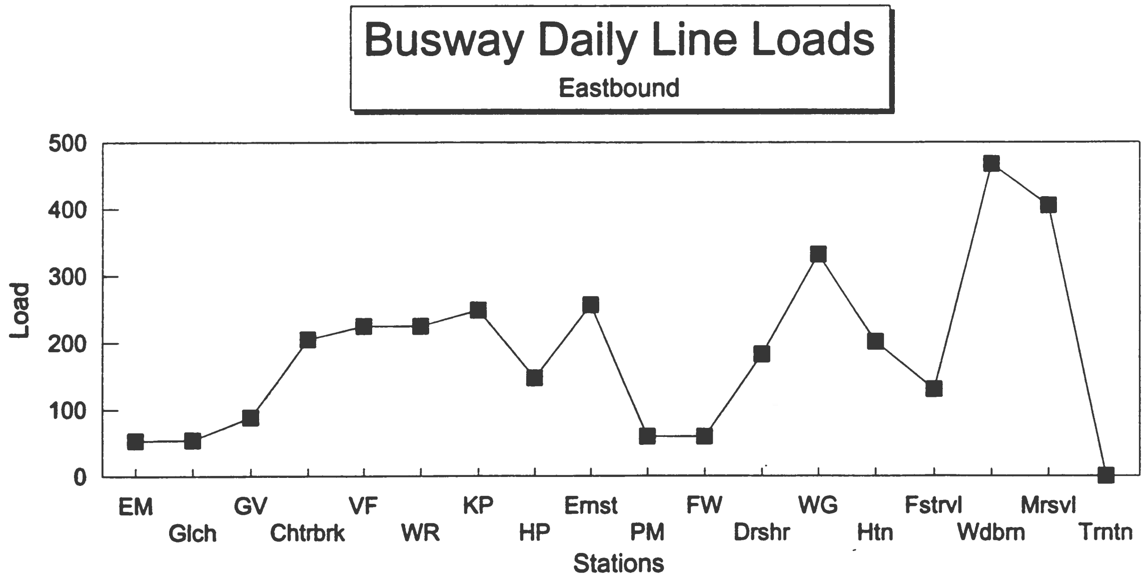
Peak hour Regional Rail ridership was estimated to be about 19% of the daily ridership, based on SEPTA's current ridership peaking characteristics for the regional rail mode. Exhibit 6-11 shows the estimated daily line loads for the Regional Rail alternative (eastbound and westbound, respectively). This figure indicates that ridership on the segment west of Chesterbrook is significantly lower than on the middle and eastern line segments. Because of the significant additional operating and capital costs associated with running the Regional Rail service to Downingtown, the low ridership on that segment prompted the service to be redefined to terminate at Glenloch. This would significantly reduce the lightly patronized train miles operated and the associated operating, maintenance and capital costs while still preserving the opportunity to connect

Exhibit 6-9



Busway Daily Line Loads

Westbound

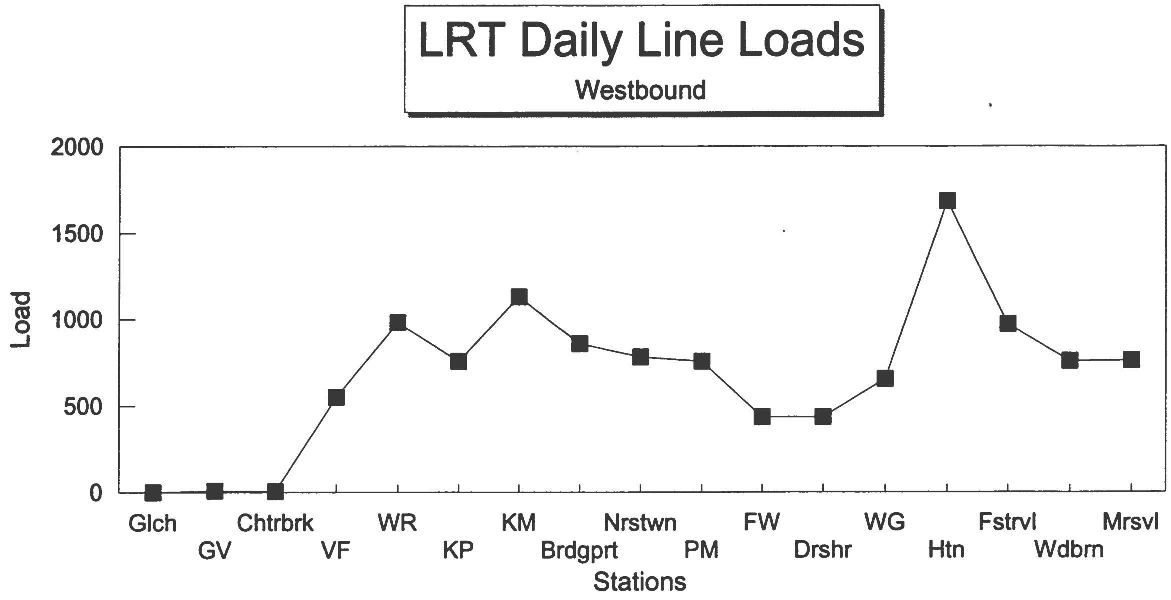


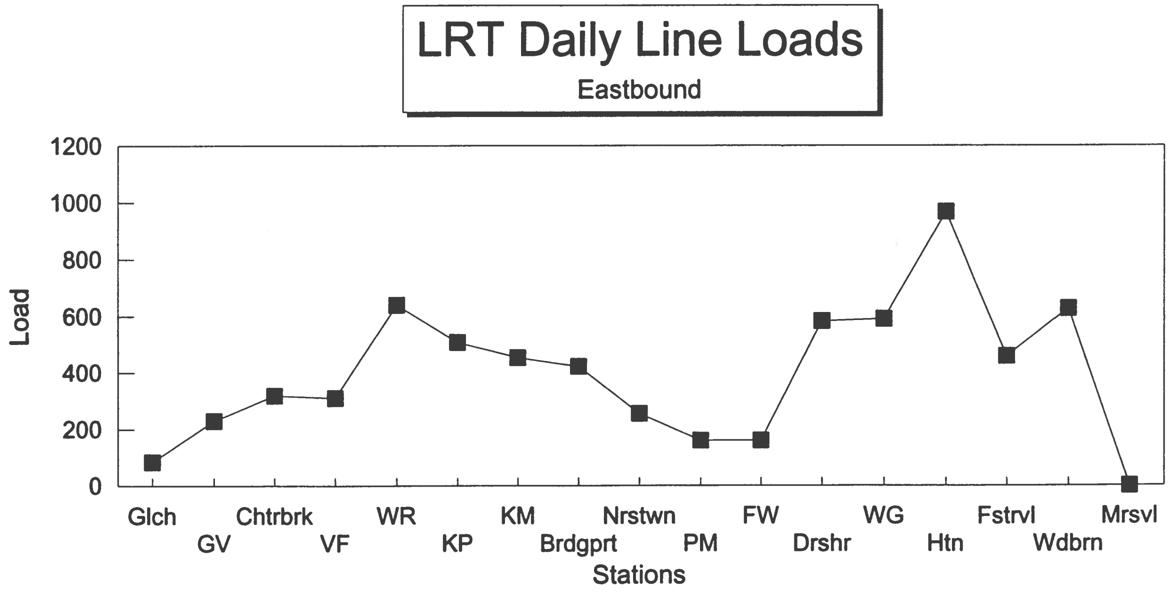
Busway Daily Line Loads

Eastbound

Manuel Padron & Associates 1993

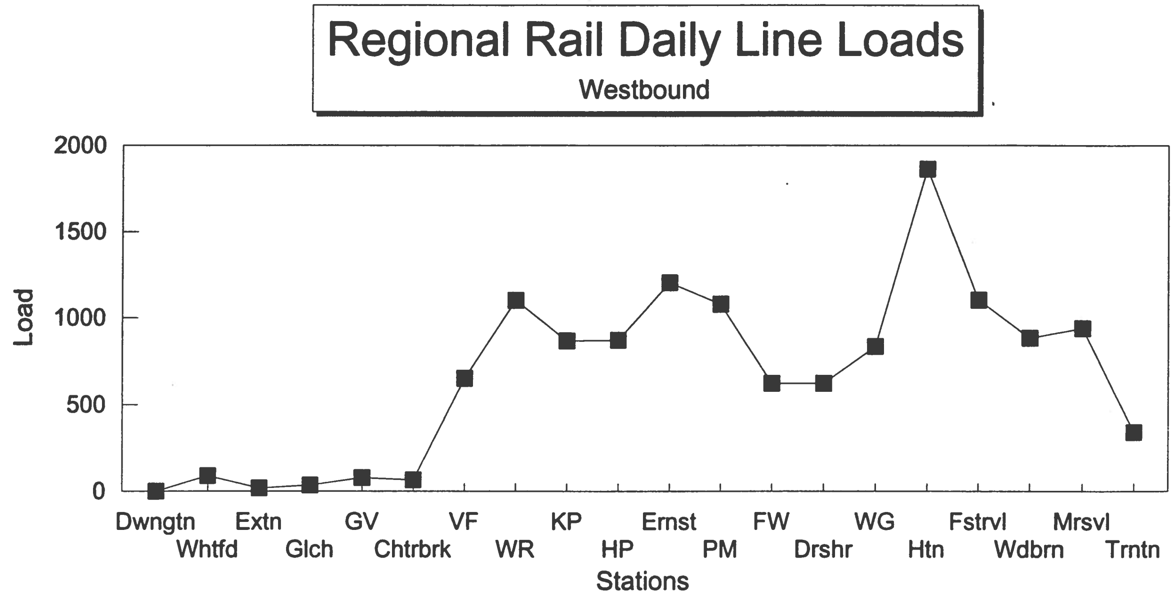
Exhibit 6-10

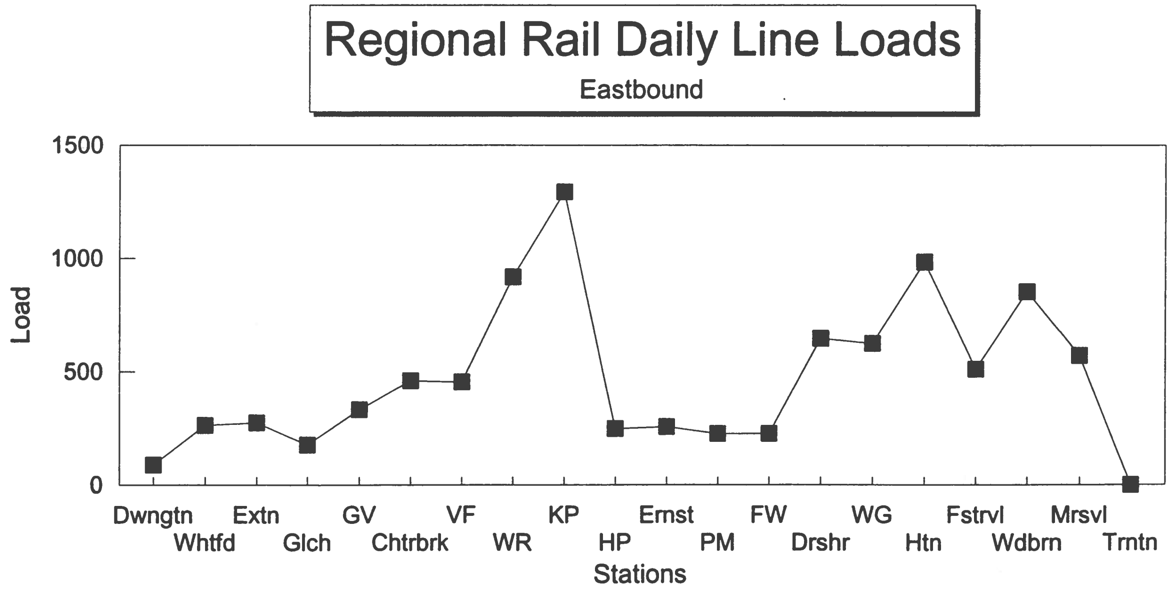




Manuel Padron & Associates 1993

Exhibit 6-11





Manuel Padron & Associates 1993

with Amtrak and SEPTA R5 services. With Glenloch as the western terminus, it is estimated that the daily ridership on the Cross County service would be decreased by about 350 trips. This assumes that nearby Exton boardings would shift to Glenloch but that all riders west of Exton would be lost. This assumption is conservative because some of the riders to or from points west of Exton could be expected to use the Cross County service by transferring to and from the R5 service or Amtrak, or by driving a greater distance and parking at Glenloch. With the western end of the service terminating at Glenloch, the estimated daily ridership for the Regional Rail alternative is 9609.

Work/Non Work Trip Proportions

An issue raised by the Technical Advisory Committee was that each of the alternative modes would be carrying a larger proportion of non-HBW trips than HBW trips during the course of a day although on a region wide basis the model estimated that 60% of transit trips are HBW trips as might be expected. This is because in the corridor itself there is a significantly greater portion of non-HBW trips being taken (approximately four times as many non\HBW trips). The actual modal split by trip purpose in the corridor is higher for HBW trips than non-HBW trips (as would normally be expected), but when the percentages are applied against the total number of trips by purpose, the actual number of non-HBW trips is higher. To better illustrate this point, the modal split was determined for trips for different portions of the region as well as the region as a whole using the Regional Rail Cross County service as an example. The results are shown in Exhibit 6-12.

Exhibit 6-12

MODAL SPLIT BY AREA AND TRIP PURPOSE (REGIONAL RAIL ALTERNATIVE)

AREA COVERED	TRIP PURPOSE	PERSON TRIPS	TRANSIT TRIPS	MODE SPLIT
All regional trips	HBW	3,317,983	502,344	15.1%
	non-HBW	9,838,777	329,208	3.3%
Trips within Philadelphia	HBW	800,531	334,868	41.8%
	non-HBW	1,748,365	204,500	11.7%
Trips outside of Philadelphia	HBW	1,977,927	45,351	2.3%
	non-HBW	7,257,468	94,414	1.3%
Trips within corridor only	HBW	824,249	19,506	2.4%
	non-HBW	3,332,282	49,108	1.5%

Urban Engineers, Inc. 1993

As shown in the table, the transit mode split for trip purposes is highest within Philadelphia. The mode split for the corridor alone compares closely with the entire region outside of Philadelphia. In all cases, transit attracts a higher percentage of HBW trips than non-HBW trips as would be expected.

Exhibit 6-13 shows the percentage of Cross County riders for each alternative as well as the modal split. Note that in each case the modal split is higher for HBW trips but the number of actual riders is greater for non-HBW trips.

Exhibit 6-13

MODAL SPLIT AND RIDERSHIP PROPORTIONS BY ALTERNATIVE FOR TRIPS MADE ENTIRELY WITHIN THE CORRIDOR

ALTERNATIVE	TRIP PURPOSE	TRANSIT TRIPS	MODE SPLIT	TOTAL NEW TRIPS	% BY TYPE
Improved Bus	HBW	17,965	2.2%	593	45%
	non-HBW	43,797	1.3%	731	55%
	Total	61,762	1.5%	1324	100%
Busway	HBW	18,907	2.3%	2038	36%
	non-HBW	46,403	1.4%	3549	64%
	Total	65,310	1.6%	5587	100%
Light Rail	HBW	19,472	2.4%	2953	32%
	non-HBW	49,029	1.5%	6153	68%
	Total	68,501	1.6%	9106	100%
Regional Rail	HBW	19,505	2.4%	3267	34%
	non-HBW	49,108	1.5%	6342	66%
	Total	68,613	1.7%	9609	100%

Urban Engineers, Inc. 1993

To test the reasonableness of a greater number of non-work trips than work trips on suburban transit routes, ridership on five existing bus routes, which approximately parallel the direction of the corridor for all or a portion of their runs, was analyzed. Although ridership data by trip purpose is not available, SEPTA was able to furnish detailed daily ridership counts by time of day made in August of 1991. The information included ridership counts for each bus run. The total daily ridership for each route, both peak and off peak, is tabulated in Exhibit 6-14. All runs that departed their starting point before 9AM and between 2:35PM and 6PM were considered peak period runs. All other runs were considered off-peak runs.

Exhibit 6-14

RIDERSHIP ON SELECTED CORRIDOR BUS ROUTES

ROUTE	FROM	TO	TIME	DAILY RIDERS	% OF DAILY RIDERS
92	West Chester	King of Prussia	Peak	213	54%
			Base	180	46%
98	Oaks/Audubon	Willow Grove Mall	Peak	612	46%
			Base	714	54%
99	Royersford	Norristown	Peak	581	39%
			Base	902	61%
127	Trenton	Oxford Valley Mall	Peak	43	41%
			Base	62	59%
130	Neshaminy Mall	Oxford Valley Mall	Peak	41	49%
			Base	42	51%

Urban Engineers, Inc. 1993

As shown in the above table, there is considerable ridership activity outside of the peak hours. On four routes it exceeds the ridership during the peak hours. Of particular note is the heavy proportion of off peak (base) ridership on Route 99 which carries most of its riders in the segment between King of Prussia and Norristown, parallel to the Cross County corridor. While it cannot be assumed that all peak trips are work trips or that all base trips are non-work trips, there is clearly a significant proportion of ridership activity occurring during non-peak hours when non-work trips are most likely to prevail. This suggests that the model's prediction that a higher proportion of daily trips would be for non-work purposes is not unreasonable.

Fare Differential

The intent of the Cross Metro Feasibility Study was to assess the ridership potential of public transportation alternatives offering different service characteristics including routing, stations served, operating speeds, headways, and connections. Because the availability of the Morrisville Line right-of-way lends itself to development of a trunk line service, it is useful to assess at a preliminary stage, for example, whether a trunk line service which would require one or two transfers for riders to reach dispersed suburban destinations would be more or less attractive than an alternative service such as a busway which would operate at lower speeds but where some routes could provide direct service to various destinations. For this reason, in forecasting ridership, a uniform fare structure, based on existing regional rail fares, was applied for all alternatives so as not to introduce a bias toward any particular alternative based on fare differentials. This approach conforms with FTA project development guidelines whose intent is not to introduce preference to any alternative.

The Regional Rail and Light Rail alternatives were defined to operate at similar maximum operating speeds on the Morrisville Line right-of-way and at similar headways. However, the Regional Rail alternative is forecasted to attract more riders because it offers a faster travel time between many corridor points than the Light Rail alternative which would divert over a longer and slower route through Norristown. The Regional Rail alternative also would offer direct service to Trenton, but the Light Rail alternative would require a transfer at Morrisville in order for riders to reach Trenton.

SEPTA's present fare structure for light rail and bus modes is significantly lower than for regional rail. For the typical trip length on a Cross County Metro service, the average fare, based on SEPTA's existing regional rail fare structure, would be $3.56. If SEPTA's existing light rail fare structure were applied, the average fare would be approximately 58% lower or $1.51. A lower fare structure would be expected to attract more riders. A report issued by the Urban Mass Transit Administration (now the FTA) in 1980 lists an expected fare elasticity of approximately 0.31 for intra-suburban routes similar to the proposed Cross County Service. Using the Midpoint or Arc Elasticity Method and the fare differential cited above to approximate the impact on ridership of the lower fare for the Light Rail alternative, the number of daily trips on the Light Rail alternative would increase to approximately 11,700 or nearly 2,100 more trips than the higher fare Regional Rail alternative. During the next stage of analysis, which would seek to select a specific preferred mode for the service, different fare structures as well as other factors would be included in the analysis in order to determine the best combination of service, operations, costs, and revenues for meeting the goals of improved transportation in the corridor.

CHAPTER 7

ENHANCED SCENARIO

ENHANCED SCENARIO

Recognizing the special challenge to transit service posed by the dispersed, highway oriented development pattern typical of suburban areas including the Cross County Corridor, the study sought to asses the impacts on ridership and financial performance of a Cross County Corridor transit service if policies were implemented to direct future suburban growth into more transit friendly patterns of development.

This chapter outlines the method utilized to calculate an enhanced land use scenario for the Cross County corridor. These calculations resulted in new Population and Employment Tables which were then used in the ridership model to estimate ridership on the alternative modes under conditions of more transit friendly patterns of land use.

All the numbers generated for use in the trip generation model were based on the assumption that total growth for the year 2010, of both population and employment, within each of the counties would not change from the numbers projected by DVRPC and agreed to by each of the counties. The enhanced numbers were therefore based on moving growth around within each county and not on any overall increase in growth within the region or movement of growth from one county to another.

The principal assumption was that, under the enhanced scenario, growth would be moved from outlying areas into the Cross County Corridor and into a denser mixed use development pattern. In order to achieve such a change in land use patterns, land use regulation, which is currently a local issue, would have to be coordinated at the county level with cooperation of municipalities both inside and outside the Cross County Corridor. Some outlying communities would have to control development to limit the amount of growth taking place. Other communities, those encompassing the cross county corridor and the station areas, would need to make land available for development at higher densities than have recently been the norm and would also need to revise zoning regulations to allow and encourage mixed use development to take place.

The Cross County Corridor had been defined, earlier in this study, as a two-mile wide corridor, extending one mile either side of the rail right of way. In Montgomery and Bucks County it was assumed that 50% of the growth projected to take place outside the corridor would be attracted into the corridor under the enhanced scenario. The equivalent assumption for Chester County was a 20% shift. This smaller number for Chester County was used after discussion with the Chester County representatives on the project steering committee. The change reflects the more rural character of the corridor in Chester County and the fact that the line will only extend part-way through the county to Glenloch. The population and employment shifts by county are shown on Exhibits 7-1 and 7-2.

Exhibit 7-1

POPULATION SHIFT TO CROSS COUNTY CORRIDOR

County	1990 POP	2010 POP	ENH 2010 POP	% CHANGE
Chester				
County-wide	376,395	460,190	460,190	0.0%
Within Corridor	137,713	163,361	174,990	7.1%
Outside Corridor	238,682	296,829	285,200	(3.9)%
Montgomery				
County-wide	678,106	744,890	744,890	0.0%
Within Corridor	141,432	140,616	174,416	24.0%
Outside Corridor	536,674	604,274	570,474	(5.6)%
Bucks				
County-wide	541,172	651,284	651,284	0.0%
Within Corridor	142,198	158,956	205,633	29.4%
Outside Corridor	398,974	492,328	445,651	(9.5)%

Urban Engineers, Inc. 1993

Exhibit 7-2

EMPLOYMENT SHIFT TO CROSS COUNTY CORRIDOR

County	1990 POP	2010 POP	ENH 2010 POP	% CHANGE
Chester				
County-wide	198,958	251,295	251,295	0.0%
Within Corridor	108,915	144,170	147,586	2.4%
Outside Corridor	90,043	107,125	103,709	(3.2)%
Montgomery				
County-wide	457,449	527,556	527,556	0.0%
Within Corridor	137,901	158,029	183,019	15.8%
Outside Corridor	319,548	369,527	344,538	(6.8)%
Bucks				
County-wide	245,340	285,573	285,573	0.0%
Within Corridor	62,058	71,225	86,758	21.8%
Outside Corridor	183,282	214,348	198,815	(7.3)%

Urban Engineers, Inc. 1993

Of the growth moved into the Cross County Corridor a further assumption was made that 50% would take place across the whole corridor and 50% would be concentrated in the station areas.

The first 50% was distributed across the corridor in proportion to the regular projected growth. In other words areas projected to grow at a greater rate were awarded a proportionally larger share of the additional growth, while areas projected to grow more slowly were assigned a smaller share. Areas projected to lose either population or employment were projected to stabilize at the existing condition but no additional growth was assigned to them.

A station area was defined as the area within a one-half mile radius of a station location. This radius was chosen as a reasonable walking distance and is based on research done elsewhere on transit sensitive design, by Jeff Zupan, Peter Calthorpe and others. Each of the station locations identified earlier in the study was examined to determine the type of development already in place, the amount of vacant land and the potential for growth, and was then classified into one of six station area prototypes.

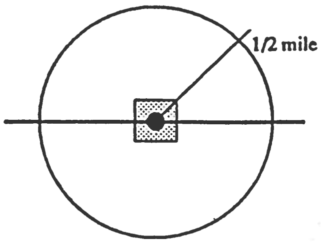
These prototypes are illustrated in Exhibit 7-3, which shows the theoretical population and employment totals for each station type as they would be configured when fully developed.

The **residential prototype** is an origin-type station which is mostly residential with a small amount of service commercial to serve the local population.
The **neighborhood prototype** is still mostly residential but includes a larger commercial component which would serve a larger area.
The **urban center** is an older urban area in which reinvestment and redevelopment would be concentrated. The center would contain a balanced mix of commercial and residential development.
The **semi-regional prototype** is a newly developed mixed use area, with a significant office population as well as service retail and residential.
The **regional prototype** is a mixed use area which includes regional scale retail with office and residential development.
The **super-regional prototype** has a similar mix of uses to the regional but includes the addition of a people mover system which expands the area within "walking distance" of the station. The station assignments by type are listed in Exhibit 7-4.

Exhibit 7-4 includes classifications for stations between Glenloch and Downingtown. Based on low ridership projections for the western end of the Regional Rail alternative, the service was re-defined to terminate at Glenloch. The enhanced land use population and employment distributions reflect that change.

Exhibit 7-3

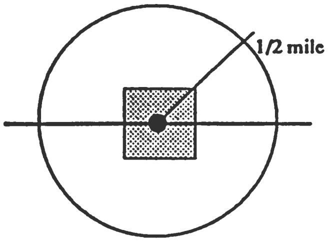
Station Area Prototypes


Residential Scenario

500 Total Acres
95% Residential Uses
5% Commercial Uses

Residential
Acres: 475
Average Density: 2 du/ac
Persons/Du: 2.8
Total Population: 2,660

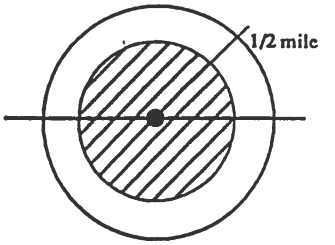
Commercial
Acres: 25
Average Density: 4,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 250


Neighborhood Scenario

500 Total Acres
75% Residential Uses
25% Commercial Uses

Residential
Acres: 350
Average Density: 2.5 du/ac
Persons/Du: 2.8
Total Population: 2,450

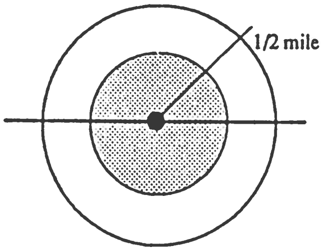
Commercial
Acres: 150
Average Density: 4,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 1,500


Urban Center Scenario

500 Total Acres
60% Residential Uses
40% Commercial Uses

Residential
Acres: 300
Average Density: 8 du/ac
Persons/Du: 2.8
Total Population: 2,500

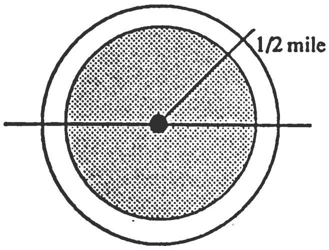
Commercial
Acres: 200
Average Density: 4,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 2,000


Semi-Regional Scenario

500 Total Acres
50% Residential Uses
50% Commercial Uses

Residential
Acres: 250
Average Density: 3 du/ac
Persons/Du: 2.8
Total Population: 2,100

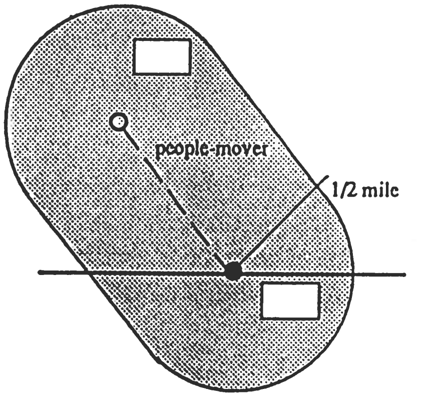
Commercial
Acres: 250
Average Density: 6,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 3,750


Regional Scenario

500 Total Acres
25% Residential Uses
75% Commercial Uses

Residential
Acres: 150
Average Density: 4 du/ac
Persons/Du: 2.8
Total Population: 1,700

Commercial
Acres: 350
Average Density: 10,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 8,750


Super Regional Scenario

1000 Total Acres
25% Residential Uses
75% Commercial Uses

Residential
Acres: 300
Average Density: 8 du/ac
Persons/Du: 2.8
Total Population: 3,400

Commercial
Acres: 700
Average Density: 10,000 sf/ac
Square Feet/ Employee: 400 sf
Total Employees: 17,500

Exhibit 7-4

STATION AREA CLASSIFICATIONS

COUNTY	STATION	TYPE
Chester	Parkesburg	Neighborhood
	Coatesville	Urban Center
	Thorndale	Residential
	Downingtown	Urban Center
	Whitford	Neighborhood
	Exton	Semi-Regional
	Glenloch	Semi-Regional
	Great Valley	Neighborhood
	Chesterbrook	Residential
	Valley Forge	Neighborhood
Montgomery	Warner Road	Neighborhood
	King of Prussia	Super-Regional
	Hughes Park	Semi-Regional
	Ernest	Semi-Regional
	Plymouth Meeting	Regional
	Fort Washington	Semi-Regional
	Dresher	Semi-Regional
	Willow Grove	Semi-Regional
	Heaton	Neighborhood
	County Line	Neighborhood
Bucks	Feasterville	Residential
	Woodbourne	Regional
	Morrisville	Super-Regional
Mercer	Trenton	Super-Regional

Urban Engineers, Inc. 1993

The growth projected to take place under the enhanced scenario was not great enough to create fully developed transit sensitive station areas by the study year of 2010. This is because of the assumption that overall growth within each county would not change under the enhanced scenario. Therefore, the available growth was assigned in proportion to the total growth required to reach the projected target population and employment figures for the various prototypical station types.

This analysis resulted in new population and employment totals for each of the Traffic Activity Zones (TAZs) within the corridor. These new numbers were used to generate new ridership forecasts for the proposed Cross County transit service. The revised population and employment totals for TAZ's in the corridor are listed in Appendices K and L of the separate Technical Appendix.

The mode split modal was run again using the Enhanced land use demographic and employment data which resulted in an increase of 19% in ridership by mode as indicated in Exhibit 7-5.

Exhibit 7-5

ENHANCED LAND USE CROSS COUNTY RIDERSHIP

DAILY RIDES	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVED BUS
W/O ENHANCED LAND USE SCENARIO	9,963	9,106	5,587	1,324
WITH ENHANCED LAND USE SCENARIO	11435	10836	6649	1576

Urban Engineers, Inc. 1993

The increase in estimated ridership resulting under enhanced land use conditions demonstrates the positive impact that more concentrated land use can have on transit ridership. The effect works both ways. As demonstrated in other cities that have installed new transit lines, the presence of the transit service makes station areas and other nearby sites more attractive to developers.

CHAPTER 8

SUMMARY

SUMMARY OF FEASIBILITY ASSESSMENT

FEASIBILITY ASSESSMENT PROCESS

The objective of the feasibility assessment summary is to present the most pertinent study analysis results into concise presentations of the strengths and weaknesses of each alternative. The focus of this presentation is to highlight the benefits of each alternative and demonstrate the feasibility of developing a fixed guideway transit facility in the Cross County corridor. The intention is not to recommend the selection of any one alternative at this time, since that effort requires more in-depth analysis in every aspect of the proposed alternatives. The summary of the feasibility assessment presents the results in general comparison with other proposed transit projects nationwide and in context with the comparable services currently operated by SEPTA.

The Federal Transit Administration's *Procedures and Technical Methods for Transit Project Planning*, February 1993, presents an evaluation framework based on four characteristics in a desirable transit project and the pertinent feasibility assessment measures within each characteristic. Selected evaluation measures used in this study were:

Cost Effectiveness - costs of each alternative measured in annual operating costs and the annualized equivalent capital costs.

- Cost per new transit rider compared with other proposed transit projects

Financial Feasibility - incremental project funds for the local contribution to the construction and ongoing operation of the alternatives will not place undue burden on either operating or capital budget.

- Revenue to cost ratio comparison with similar existing services (Farebox

Recovery)

- Cash flow of sources and uses of existing operating and capital funds

Effectiveness - benefits can be measured in terms of mobility, environmental protection, urban development and energy conservation.

- Increased transit ridership
- Improved mobility (transit accessibility) to an increased percentage of the regional population
- Reduced highway congestion
- Focused urban development
- Reduced automobile pollutants
- Reduced energy consumption

The emphasis of the effectiveness assessment was in the estimate of transit ridership, improved mobility, and reduced energy consumption.

Equity - costs and benefits are distributed fairly across the regional population groups.

- Improved transit accessibility to an increased number of the regional transit-needy population (zero and one car households)

COST EFFECTIVENESS

The comparison with other proposed fixed guideway transit projects nationwide is presented by using the cost effectiveness measure developed by the Federal Transit Administration. This measure is a ratio of the total cost per new transit rider which was developed by the FTA to reasonably rank the cost and contribution of each proposed project:

$$\textbf{Incremental Cost/New Rider} = \frac{\textbf{\$Capital + \$Oper \& Maint + \$Travel Time}}{\textbf{Riders}}$$

Where:

$Capital is the annualized equivalent capital cost calculated over the life of each capital component.

$Oper & Maint is the annual operating and maintenance cost.

$Travel Time is the annual value of travel time savings for existing riders.

Riders is the annual transit ridership measured in linked trips.

The equation variables are measured in the difference or incremental benefit over the Improved Bus alternative, which serves as the study baseline for comparison purposes. The development of the Improved Bus alternative is to establish an alternative that optimizes the existing bus services with limited or low capital investment. The requirement for an improved bus alternative to serve as the study baseline is part of the FTA-defined project development process.

Additional Considerations

This cost effectiveness measure has been questioned by the transit industry as not adequately accounting for all of the societal benefits generated by fixed guideway transit projects. The most recent transportation legislation, Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), proposes the consideration of additional societal or user benefit measures as quantified in microeconomic theory of consumer surplus. The measures that may be of interest to this feasibility assessment include the previously noted user benefit measures and the following:

- Reduction in auto travel in a congested corridor, measured in vehicle miles of travel

- Increased regional transit accessibility, measured in the additional regional population served by fixed guideway transit services

- Improvement in air quality, measured in the annual reduction in air pollutants

- Reduction in energy consumption, measured in an equivalent kilowatt hours of energy

In addition, the cost effectiveness measure has been modified to a value of cost per user benefit, which is the optional FTA project comparative measure at this time; however, no definitive policy change has been published. The optional additional benefits and measure, which is not yet official FTA policy, have not been used to measure cost effectiveness in this study, but they may be considered at the next stage of analysis in which more detailed information on alternatives would be developed.

Methodology

The cost effectiveness index for each alternative was calculated using two sets of cost assumptions. The first set of assumptions, Fully Allocated costs, are based on the inclusion of all potential system costs including additional headquarters staff. The second set of assumptions, Base costs, represents the cost conditions expected to be achievable for a new service. In addition to holding headquarters staff costs fixed, the Base cost assumptions include a few additional cost considerations in the estimation of operating costs.

- For example, for the Regional Rail alternative, vehicle maintenance would be performed at the recently constructed Frazer facility. This facility is modern, well equipped and able to accommodate the additional vehicles required for the regional rail alternative with only minor capital upgrades. Utilization of the already constructed and operational Frazer facility to maintain additional rail vehicles would only require additional maintenance staff and not require additional headquarters staff.

- Also, for the Base cost assumption, increased operating efficiency was identified by operating only single articulated cars for the Light Rail alternative and reducing the regional rail staffing to a two-man crew for two car trains. The use of articulated cars for the Light Rail alternative decreases operating and maintenance costs by automatically reducing the chewing to one man and peak vehicles by 50%.

- A one car regional rail operation was examined but, but because Amtrak operating rules require a two-car operation, it was not considered in the Base cost assumptions.

- The Busway Alternative operates identically to the current operation in the Suburban Transit Division. Areas of operating efficiency were examined but could not be justified. For example, ridership levels for the busway alternative do not demand the need for articulated buses which would reduce operator and vehicle costs. Otherwise, the operating characteristics of the alternatives match those of the comparable modes in operation at SEPTA today.

The operating and capital costs and associated cost effectiveness index for each alternative under both Fully Allocated and Base cost assumptions are summarized in Exhibit 8-1.

Exhibit 8-1

SUMMARY OF COSTS AND COST EFFECTIVENESS

	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVE BUS
Daily Trips	9609	9106	5587	1324
FULL COST ASSUMPTIONS				
Annual Operating*	$26,468	$9,700	$6,378	$5,679
Total Capital*	$393,561	$371,510	$476,320	$12,849
Annualized Capital*	$32,239	$30,345	$41,118	$1,473
Cost Index**	$20.74	$14.09	$31.55	N/A
BASE COST ASSUMPTIONS				
Annual Operating*	$20,897	$7,093	$5,725	$5,116
Total Capital*	$393,561	$350,338	$476,320	$12,849
Annualized Capital*	$32,239	$28,523	$41,118	$1,473
Cost Index**	$18.73	$12.43	$31.48	N/A

*** (1,000's)**
**** Dollars per Rider**

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To add perspective to the performance measures listed in Exhibit 8-1, Exhibits 8-2a and 8-2b list the projected ridership, estimated capital costs, and computed cost indices for other proposed fixed guideway transit projects listed in *Report on Funding Levels and Allocation of Funds (June 1992)* by the United States Department of Transportation.

The projected ridership, capital costs, and cost effectiveness index of a Cross County Corridor rail transit service fall well within the range of estimated performance of other projects which have advanced to further stages of study.

Exhibit 8-2a

RIDERSHIP, COST & EFFECTIVENESS CHARACTERISTICS OF PROPOSED FIXED GUIDEWAY TRANSIT PROJECTS

PROJECT BY MODE	LOCATION	ESTIMATED DAILY TRIPS	ESTIMATED CAPITAL COSTS ($Million)	COST EFF. INDEX ($/NEW RIDER)	* PHASE
LIGHT RAIL					
S. Oak Cliff Corridor	Dallas, TX	20,000	$360	$9	4
South LRT	Salt Lake City, UT	6,000	$230	$7	3
Tasman Corridor	San Jose, CA	5,000 - 7,000	$480	$40	3
Northwest/North Central	Austin, TX	Not Reported	$200	$15	2
North Central Corridor	Dallas, TX	24,300	$200	$7	2
Southwest Corridor	Denver, CO	Not Reported	$200	$6	2
South Corridor	Kansas City, MO	Not Reported	$245	$50 - 89	2
East-West Corridor	Milwaukee, WI	Not Reported	$332	$8 - 11 +	2
Central Corridor	Minn-St.Paul, MN	Not Reported	$470	Not Reported	2
Canal Street Corridor	New Orleans, LA	22,000	$90	$7 - 9	2
South Corridor	Sacramento, CA	Not Reported	$200	$8	2
Mid Coast Corridor	San Diego, CA	9,550	$350	$11 - 14	2
St. Clair Corridor	St. Louis, MO	13,100	$213	Not Reported	2
Hillsboro Corridor	Portland, OR	4,660	$200	$75	2
Westside LRT	Portland, OR	25,200	$515	$19	4
Newark Air Link	Newark, NJ	40,000	$600 - $1,000	Not Reported	2
Hudson Waterfront	Jersey City, NJ	Not Reported	$524 - 1,130	$7 - 27	2
OSCAR	Orlando, FL	4,800 - 8,200	$43 - 48	$6 - 16	2
Central Area Circulator	Chicago, IL	120,000	$750	$17	3
BWI Airport Extension	Baltimore, MD	2,500	$35	$16	3
Hunt Valley Extension	Baltimore, MD	2,600	$48.7	$11	4
Penn Station Extension	Baltimore, MD	800	$17.6	$17	4

* Phase Key

1. In System Planning Stage
2. In Major Investment Analysis Stage
3. In Preliminary Engineering Stage
4. Under Design

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Exhibit 8-2b

RIDERSHIP, COST & EFFECTIVENESS CHARACTERISTICS OF PROPOSED FIXED GUIDEWAY TRANSIT PROJECTS

PROJECT BY MODE	LOCATION	ESTIMATED DAILY TRIPS	ESTIMATED CAPITAL COSTS ($Million)	COST EFF. INDEX ($/NEW RIDER)	* PHASE
BUSWAY					
Airport Busway	Pittsburgh, PA	11,000	$224	$5	3
Regional Bus Plan	Houston, TX	Not Reported	$1,250	$4	3
I-405/SR-55 Transitway	Orange County, CA	Not Reported	$424	$4	3
COMMUTER RAIL					
Boston to Portland Rail Line	MA to ME	1,000	$50+	Not Reported	2
Greensboro Commuter Rail	Atlanta, GA	Not Reported	Not Reported	Not Reported	1
Dallas-Fort Worth Rail Line	Dallas, TX	8,000	$120	Not Reported	1
Los Angeles/San Diego Rail	Los Angeles, CA	16,500	$191.8+	Not Reported	1

* Phase Key

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1. In System Planning Stage
2. In Major Investment Analysis Stage
3. In Preliminary Engineering Stage
4. Under Design

FINANCIAL FEASIBILITY

Farebox Recovery

The operating efficiency of the proposed alternatives can be measured by calculating the farebox recovery ratios for each alternative and comparing the results to similar operations within the SEPTA system. The farebox recovery ratio for this analysis is calculated by dividing the estimated annual passenger fare revenue by the annual operating expense of each alternative. The farebox recovery ratios were calculated using both the Fully Allocated and Base cost assumptions and with fixed headquarters' staff costs for each alternative and related service. The farebox recovery ratios were compared to similar services operated by SEPTA. They are tabulated in Exhibit 8-3.

Exhibit 8-3

FAREBOX RECOVERY RATIOS

Alternative vs Similar SEPTA service	Annual Revenue ($1,000's)	Farebox Recovery	
		Full Cost Assump.	Base Cost Assump
IMPROVED BUS	**$540**	**10%**	**11%**
Frontier District (bus)		38%	44%
Victory District (bus)		50%	62%
BUSWAY	**$2,279**	**36%**	**40%**
Frontier District (bus)		38%	44%
Victory District (bus)		50%	62%
LIGHT RAIL	**$4,125**	**43%**	**58%**
Norristown High Speed Line		42%	50%
Media/Sharon Hill Lines		54%	62%
REGIONAL RAIL	**$10,262**	**39%**	**49%**
Regional Rail (System)		33%	53%
R1 Airport Line		28%	N/A
R2 Wilmington/Warminster		37%	N/A
R3 W Chester/W Trenton		42%	N/A
R4 Downingtown/Doylestown		48%	N/A
R6 Norristown/Cynywd		26%	N/A
R7 Trenton/Chest Hill East		53%	N/A
R8 Chest Hill West/Fox Chase		53%	N/A

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The Improved Bus alternative has a farebox recovery ratio of 11% based on an average fare of $1.36, which is significantly lower than both the Frontier or Victory District. The primary reason for the low farebox recovery ratio is the substantially lower level of ridership than any of the other alternatives. The Busway alternative has a farebox recovery ratio of 40% based on the projected ridership, estimated operating and maintenance costs and the average fare of $1.36 from the Frontier bus service. This recovery ratio is just below the range of ratios from the Victory and Frontier Districts and represents a reasonable estimate for this alternative. The Light Rail alternative has a farebox recovery ratio of 58% which is higher than the Norristown High Speed Line and just lower than the Media Sharon Hill Line. The ratio is based on an average fare of $1.51 from the Norristown High Speed Line and estimated operating costs and projected ridership for this alternative. The Light Rail alternative under the base cost assumptions has a higher farebox recovery ratio due in part to the use of articulated cars which reduces operating and maintenance costs by decreasing the amount of annual vehicle miles, vehicle hours and peak vehicles. The farebox recovery ratio for the Regional Rail alternative is 49% and is based on an average fare of $3.56 from the east side of the R7 line and projected ridership and estimated operating costs. The eastern portion of R7 was selected because it is comparable in length, includes six zones and would be the most similar of the existing rail lines to the regional rail alternative.

The farebox recovery ratios for bus and light rail were calculated from SEPTA's internal cost and revenue reporting systems for FY 1992 while the regional rail figures were calculated from the same reporting system for 1991. Regional rail farebox recovery ratios for 1992 were not used because of the effect the Railworks capital program had on the productivity of commuter rail operations.

New System Funding

Capital funding for the preferred alternative will be obtained from three sources including Federal, State and Local funds. The enactment of the Intermodal Surface Transportation

Efficiency Act has allowed for Federal funding to be up to 80% of the net project capital costs. The remaining 20% can be provided from state and local authorities. The FTA distributes Federal funds for new systems through three funding programs:

- **Section 3 -** This program provides funding for the establishment of new rail or busway projects, the improvement and maintenance of existing rail and other fixed guideway systems and the upgrading of bus systems. The three categories that comprise the Section 3 program are bus and bus related, fixed guideway modernization and new systems. Funding for the Cross County Corridor selected alternative falls under the new systems category. New systems funding under ISTEA is allocated yearly on a discretionary basis by Congress. The proposed projects are ranked by specific criteria that include the cost per new rider index presented in the earlier Cost Effectiveness section. Major Investment Analysis is the next step in the project development process and includes consideration of alternative highway improvements to identify a major multi-modal investment plan for the corridor and to justify the level of investment involved when proposing a new fixed guideway system.

- **Flexible Funding -** ISTEA legislation has provided the flexibility of allowing states and local governments the capability to use Federal Highway funds for transit projects. Flexible funds can be transferred to Section 9, 16 and 18 and are derived from three sources including:

  - Surface Transportation Program (STP);
  - Congestion Mitigation and Air Quality (CMAQ) Program; and,
  - National Highway System Funds (NHS)

  STP is the largest category of flexible funds and can be used for all projects eligible for funding under current FTA grant programs excluding Section 9 operating assistance. CMAQ funds are used to support transportation projects in air quality non-attainment areas. The Cross County Corridor is in a non-attainment area and would be eligible for consideration to receive this category of funding.

- **Section 9 -** Section 9 is a formula grant program for urbanized areas providing capital, operating and planning assistance for mass transportation. Funds are apportioned to urbanized areas utilizing a formula based on population, population density and factors associated with transit service and ridership. Section 9 funding has increased under ISTEA because flexible funds can be transferred and made available for transit improvements such as new fixed guideway projects.

Preliminary estimates for cash flow analyses of the existing SEPTA budgets with the addition of the improved bus, busway, regional rail and light rail alternatives were prepared. Operating and expense data for the existing system was obtained from SEPTA's Fiscal Year 1994 Operating Budget and combined with the operating and maintenance, capital costs and operating revenues for the proposed alternatives. A potential funding scenario labeled Revenue Available for Capital was included in each cash flow statement to illustrate the 80% Federal and 20% Local/State funding levels. In addition, Federal subsidies were increased for new rail and bus service using the allocation formula for Section 9 funds in urbanized areas above 200,000 in population as outlined in the Section 15 Annual Report. For example the following allocation formula was utilized for the rail alternatives:

Rail Tier 33.29% of $27.2 million (1993 Subsidy) = $9.1 million

Base portion	95.61% of $9.1 million = $8.7 million
Revenue vehicle miles	60.00% of $8.7 million = $5.2 million
Route miles	40.00% of $8.7 million = $3.5 million
Incentive portion	4.39% of $9.1 million = $0.4 million

The Light Rail alternative will increase the Section 9 subsidy by approximately $0.7 million and the Regional Rail alternative will generate an additional subsidy of approximately $1.0 million. Additional Section 9 subsidies for both the Improved Bus and Busway alternatives is approximately $0.6 million. These amounts have been added to the Federal subsidy line items beginning in the year 2000 for each of the cash flow statements.

The cash flow statements that were prepared were not intended to present the expected scenario that will occur with the construction and operation of an alternative, but instead represent a preliminary estimate of expenses and revenues to provide insight into the possible effects of a new service. The cash flow analysis assumes that design and construction will take place from FY1996 to FY2000 and that revenue operation will begin in FY 2001. A 4% annual inflation rate is assumed for both capital and operating and maintenance costs. Highlights of the cash flow analysis are summarized in Exhibit 8-4. A detailed description of the cash flow analysis and year-by-year cash flow charts for each alternative are included in Appendix 3.

Exhibit 8-4

CASH FLOW SUMMARY

Cost Description (Costs shown are in $ millions)	Improve Bus	Busway	Light Rail	Regional Rail
Total Capital Cost, 1993$	12.8	$476.3	$350.3	$393.6
Total Capital Cost FY 1996 to FY 2000*	$15.7	$580.4	$426.9	$479.6
FY 2001 Oper.& Maint. Cost	$6.8	$7.8	$9.6	$28.6
FY 2001 Additional Revenue	$0.7	$3.1	$5.6	$14.1
FY 2001 Deficit	$5.4	$3.9	$1.9	$13.1

* Based on Year of Expenditure Dollars

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EFFECTIVENESS

Environmental

There are numerous environmental benefits associated with a shift of travel from private automobiles to public transit in the Cross County corridor. Some of these are easily quantified; others are more subjective in nature or require a more exhaustive analysis to quantify. Most of the easily quantified benefits stem directly from the reduction in automobile travel resulting from a shift to transit in the corridor. These include potential savings in fuel and energy consumption which have related positive impacts in improving air quality. Knowing the number of new transit trips for each alternative, and the associated average length of trips permits an approximate calculation of energy savings. These are summarized in Exhibit 8-5 on an annual basis in terms of kilowatt hours (KWH).

Exhibit 8-5

SUMMARY OF ENERGY CONSUMPTION

	Regional Rail	Light Rail	Busway	Improved Bus
Average Trip Length (miles)	7.77	7.12	7.34	6.66
Annual Auto Miles Saved (1,000's)	18,665	16,209	10,252	2,204
Annual Gasoline Saved (gallons)	746,619	648,347	410,086	88,178
Annual Energy Savings (1000 kwh)	(23,122)	640	(14,146)	(22,906)

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The energy savings are based on the assumption that all trips are former automobile trips and takes into account the energy expended in operating each Cross County service alternative including additional connecting bus services included in the operating plan to provide better access to each alternative. As indicated, only the Light Rail alternative shows a net savings in energy. The Regional Rail alternative shows a net energy loss because present operating restrictions related to the signal system require that Regional Rail trains operating on Amtrak lines (as between Morrisville and Trenton) must have a minimum of two cars per train. Otherwise the Regional Rail alternative could accommodate the projected ridership with single car trains and consume only half as much energy resulting in a net annual energy savings of 153 KWH. The net loss of energy of the two bus alternatives is due to the lower energy efficiency of buses (relative to rail), and the level of service provided relative to the lower number of riders the bus alternatives attract. That is to say some of the buses would be running with lighter passenger loads. The above does not take into account secondary energy savings such as would result from a decrease in general traffic congestion as some drivers shift to travel on the Cross County service.

Any net savings in energy would have a beneficial effect on air quality. Furthermore, a shift in energy consumption to either of the rail modes has additional benefits in that electricity is generated at a single point where the effects of burning fossil fuels can be better monitored and controlled, and where alternative energy sources such as nuclear and hydro can be utilized. PECO Energy Company has both nuclear and hydro plants in its system.

In the longer term, the availability of public transportation in the corridor, especially the rail modes, can be expected to influence land use in environmentally positive ways. By tending to focus development in more concentrated patterns with better access to transit, the rail modes will be able to attract greater numbers of riders resulting in a further decrease in auto trips which will further reduce energy consumption and traffic congestion, all of which will benefit air quality. More concentrated development will also reduce the demand for development of open space allowing for greater diversity of wildlife, more recreational opportunities, and better absorption of storm runoff.

Travel Time Savings

In most cases the travel time savings afforded by public transportation improvements accrue to existing users of public transportation rather than to motorists who switch to public transportation. Exceptions would be limited to travel to and from central business districts where highways are severely congested and public transportation offers good service with minimal or no transfer or waiting time. In much of the Cross County corridor it can be expected that the majority of riders, nearly all of whom would switch from automobiles, will not experience any measurable savings in travel time, rather, they will likely find travel times longer due to waiting and transfer times. An exception to this expectation would apply to those peak hour commuters who presently use portions of the parallel Pennsylvania Turnpike and experience severe delays due to backups at toll booths and ramp exits to local roads. For these commuters, a Cross County service may reduce their travel time.

Enhanced Conditions

The suburban environment through which a Cross County Metro service would run has developed in response to the automobile as the primary means of travel. Land use tends to be of low density with traffic generators dispersed over a wide area. Serving this type of development with public transportation is a special challenge. Recognizing the environmental benefits of more compact development, the ability of transit service to encourage such development, and the likelihood of higher transit ridership and operating performance that would derive from more compact development, the study analyzed an enhanced land use scenario that shifted a higher portion of future development into the two-mile wide corridor and into the station areas (See Chapter 7). This strategy resulted in a 19% increase in ridership on a Cross County Metro Service. Using the same Base cost assumptions described above, the higher ridership improved the financial performance of the service. To further improve the performance of the service, a set of additional favorable Enhanced Cost conditions were assumed:

- Because the Cross County Service would operate with a fleet of newer vehicles reflecting technological advancements, operating costs could be lower than those experienced for similar modes currently operated by SEPTA.

- It was assumed that technical and staffing issues related to Regional Rail operations could be resolved to permit operation of single car Regional Rail trains with a single staff member on board, and without any additional fare collection personnel at Regional Rail stations.

PERFORMANCE SUMMARY

Exhibits 8-6 and 8-7 summarize the performance of each alternative for the existing 2010 population and employment forecasts and the Enhanced Land Use Scenario which assumes a more transit-friendly distribution of future population and employment. For the existing population and employment forecasts (Base Land Use) performance under the Fully Allocated and Base cost assumptions are shown for comparison between expected cost assumptions and existing SEPTA operating conditions. For the enhanced land use scenario, performance under the Base Cost Assumptions and the Enhanced Cost assumptions are shown for comparison between expected operating conditions and more favorable conditions that might be achieved.

The following paragraphs explain the three sets of cost assumptions:

Fully Allocated Cost Conditions

The fully allocated cost conditions are based on existing SEPTA system operating costs and procedures as appropriate for each modal alternative. All costs are fully allocated and include appropriate increases in general administrative and headquarters costs.

Exhibit 8-6

SUMMARY OF BASE LAND USE RIDERSHIP AND COSTS

	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVE BUS
Route Length (mi)	48	47.6	46.4	63.6
No. of Stations	17	18	16	N/A
Daily Trips	9609	9106	5587	1324
Annual Revenue*	$10,262	$4,125	$2,279	$540
FULL COST ASSUMPTIONS				
Annual Operating*	$26,468	$9,700	$6,378	$5,679
Farebox Recovery	39%	43%	36%	10%
Total Capital*	$393,561	$371,510	$476,320	$12,849
Annualized Capital*	$32,239	$30,345	$41,118	$1,473
Cost Index**	$20.74	$14.09	$31.55	N/A
BASE COST ASSUMPTIONS				
Annual Operating*	$20,897	$7,093	$5,725	$5,116
Farebox Recovery	49%	58%	40%	11%
Total Capital*	$393,561	$350,338	$476,320	$12,849
Annualized Capital*	$32,239	$28,523	$41,118	$1,473
Cost Index**	$18.73	$12.43	$31.48	N/A

*** (1,000's)**
**** Dollars per Rider**

Regional Rail Route Length: Glenloch to Trenton
Light Rail Route Length: Glenloch to Morrisville via Norristown
Busway Route Length: Glenloch to Morrisville
Improved Bus Route Length: Via US 202, PA Turnpike, & local roads.

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Exhibit 8-7

SUMMARY OF ENHANCED LAND USE RIDERSHIP AND COSTS

	REGIONAL RAIL	LIGHT RAIL	BUSWAY	IMPROVE BUS
Route Length (mi)	48	47.6	46.4	63.6
No. of Stations	17	18	16	N/A
Daily Trips	11,435	10,836	6,649	1,576
Annual Revenue*	$12,212	$4,909	$2,713	$643
BASE COST ASSUMPTIONS				
Annual Operating*	$20,897	$7,093	$5,725	$5,116
Farebox Recovery	58%	69%	47%	13%
Total Capital*	$393,561	$350,338	$476,320	$12,849
Annualized Capital*	$32,239	$28,523	$41,118	$1,473
Cost Index**	$15.74	$10.45	$26.45	N/A
ENHANCED COST ASSUMPTIONS				
Annual Operating*	$14,358	$6,727	$5,557	$4,957
Farebox Recovery	85%	73%	49%	13%
Total Capital*	$362,116	$350,338	$476,320	$12,849
Annualized Capital*	$29,518	$28,523	$41,118	$1,473
Cost Index**	$12.66	$10.37	$26.44	N/A

*** (1,000's)**
**** Dollars/rider**

Regional Rail Route Length: Glenloch to Trenton
Light Rail Route Length: Glenloch to Morrisville via Norristown
Busway Route Length: Glenloch to Morrisville
Improved Bus Route Length: Via US 202, PA Turnpike, & local roads.

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Base Case Cost Conditions

These conditions are based on the assumption that modest improvements to productivity can be achieved by the time of introduction of a new service and that certain system costs would not increase or would increase at lower levels:

- Includes no incremental increase in headquarters allocation.
- For the Light Rail Alternative, allows for use of single articulated vehicles to meet estimated peak period passenger demand in lieu of two-car trains.
- For the Regional Rail Alternative, assumes staff of two per train.

Enhanced Cost Conditions

These conditions assume that maximum productivity and cost efficiencies can be achieved with the introduction of a new service:

- Includes no incremental increase in headquarters allocation.
- Assumes modest reduction in maintenance costs due to new fleet of vehicles with state of the art technology.
- For Light Rail Alternative assumes use of single articulated vehicles.

- For Regional Rail Alternative assumes use of single car trains to meet estimated demand (Current Amtrak rules require minimum 2-car trains to operate into Trenton), staff of one person per train, and no additional personnel on board or at stations for fare collection.

ADDITIONAL FACTORS TO ENHANCE PERFORMANCE

As discussed above, the Cross County Metro service, particularly the light rail mode, compares favorably in performance with most other SEPTA rail lines. That it does so in a non-radial corridor with dispersed land use patterns suggests that the Cross County Metro concept has considerable merit and should be further explored. This study of the Cross County corridor, as formulated, is conservative in most of its assumptions. A more detailed and exhaustive study of the Cross County corridor could be expected to yield further improvement in expected performance. Following are some of the issues that should be further addressed and that would enhance performance:

Ridership Issues

- **Fare Elasticity**

  As noted in Chapter 6, a lower fare structure for the Light Rail Alternative, similar to SEPTA's existing fare structure for light rail, could increase daily Light Rail ridership to approximately 11,700. This higher level of ridership would improve the performance of the Light Rail Alternative: The Cost Recovery ratio would increase to 75%, and the Cost Index would drop to $9.33 per new rider.

- **External Ridership**

The ridership model used for the study only uses population and employment data for the Delaware Valley as received from DVRPC. The projected ridership on the Cross County Metro, therefore, only accounts for travel between origins and destinations within the region. It does not include potential trips that would originate or terminate outside of the region, such as trips to and from points in northern New Jersey or New York City, which might use the Cross County Metro.

Exhibit 8-8 shows the trips to New York City from the counties served by the Cross County corridor. The data was obtained from the 1990 census.

Exhibit 8-8

1990 ONE WAY TRIPS TO NEW YORK CITY

Originating County	Trips by All Modes	Trips by Rail
Chester	189	95
Montgomery	570	300
Bucks	2800	2000
Totals	3559	2395

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These numbers represent one way travel. The actual daily trips would be approximately double these numbers since most trips are made by commuters. The availability of a connection with New Jersey Transit at Trenton may attract some additional non-work trips.

From Chester County Amtrak offers limited through and connecting service to

New York City. Based on existing Amtrak schedules, a morning trip from Malvern (via Amtrak) and from Great Valley at the same time of day (via Cross County) would have the same travel time. The trip via the Cross County would end up connecting at Trenton with the same Amtrak train from Malvern. However, because the Cross County would offer 15 minute headways and therefore much greater choice of departure times, it can be expected that the Cross County service would draw some riders from the Amtrak service as well as from those who presently drive using adjacent highways.

From Montgomery County Amtrak offers limited through service from Ardmore. Additional connecting service via 30th Street using SEPTA/Amtrak is also available. Of the 300 rail trips from Montgomery County, approximately 150 are from Lower Merion Township which is convenient to both the existing Amtrak/R5 route and the Cross County. The Cross County would be more convenient for the remainder of Montgomery County. With more frequent headways and better access to more of Montgomery County, the Cross County has the potential of attracting a significant portion of the 300 existing riders but the split is difficult to predict. Via the Cross County, NJT offers more frequent connecting trains and lower fares from Trenton to New York City but slower service. From 30th Street, Amtrak offers faster service but higher fares. For regular commuters the choice would likely depend on the specifics of the schedules, the connecting times (at Trenton or 30th Street), and the reliability of connections as well as total cost. Convenient station access and parking will also come into play.

From Bucks County, existing rail riders must use stations on SEPTA's R7 route and transfer to NJT or Amtrak at Trenton or drive to Trenton and park. With 15 minute headways and shorter driving time and easier parking, the Cross County would likely pick up a significant portion of the existing 2000 rail users. Since rail already has 71 % of the trips from Bucks County (2000 out of 2800) it is difficult to predict how many drivers will be attracted to rail, but the greater accessibility of rail service via the Cross County could be expected to attract some additional commuters to rail.

In light of the existing travel volumes to New York City and with the Regional Rail version of a Cross County Metro providing frequent service into Trenton where direct connection to NJT or Amtrak can be made, it is reasonable to assume that trips to and from points outside of the region would boost Cross County daily ridership, especially Regional Rail, to well over 10,000 average weekday trips.

- **Clean Air Act**

The Philadelphia region through which the Cross County Metro Corridor passes has been designated as a Non-attainment Area by the United States Environmental Protection Agency (EPA). This designation has been accepted by the Pennsylvania Department of Environmental Resources (DER) which has adopted rules designed to curb automobile emissions as part of a strategy to bring the region into compliance with the requirements of the Clean Air Act. One of these rules is the Employer Trip Reduction Program which requires employers in the region with 100 or more employees to increase the average vehicle occupancy of their commuting work force. The effects of this regulation on public transit ridership has not been taken into account in this study of the Cross County Metro Corridor, but it can be expected that the effect of the program will be to increase ridership on the Cross County Metro to higher levels than the numbers projected in this feasibility study.

- **Pennsylvania Turnpike Congestion**

The Pennsylvania Turnpike parallels a significant portion of the Cross County

Corridor and is used by many commuters to access jobs in office parks near the turnpike interchanges. Many major malls and other retail center are also located near the turnpike interchanges. In recent years an additional lane has been added to portions of the turnpike in the corridor to relieve congestion created by the increasing levels of local commuter traffic using the highway. While this has helped traffic flow on the main road, there are still reports of severe congestion and delays at the tollbooths during peak travel periods. These delays increase travel time, particularly for peak period commuters who might be attracted to a Cross County Metro service.

The highway travel times used in the study to predict ridership on a Cross County Metro Service are based on average travel times over multiple roadway links, including the segments of the Pennsylvania Turnpike. These travel times are in files maintained by the DVRPC and used for this study. The travel times in these files, while including factors such as tollbooth delays, represent average travel times and are not sensitive to variations by time of day. The multiple link aspect of the average travel time downplays the effect of tollbooth delays for trips using the Turnpike. Travel times used in the model are also based on a 2 to 3 hour peak period. Since toll delays occur over a shorter peak, this also downplays the effect of delays on peak hour commuters. It is expected that a more detailed analysis of modal split, based on time of day travel times, would indicate a higher shift of peak trips to a Cross County Metro service.

Operating Issues

- **Staffing Requirements**

The operating costs for the Regional Rail service used in this analysis are based on two crew members per train, which represents a reduction of 1.5 persons from SEPTA's present average of 3.5 persons per train. Conceptually there is no reason why regional rail trains could not operate with a single crew person similar to light rail, especially if a modified fare system were implemented that would significantly reduce the staffing needed to collect fares. Modification to the design of the cars could also enhance the feasibility of single person operation. There are restrictions to operating on Amtrak lines which currently make single person operation unfeasible. Since only a short segment of the Regional Rail service would operate on Amtrak (between Morrisville and Trenton), ways should be explored to operate the trains, at least over most of the route, with one crew member. This would significantly lower the operating costs for Regional Rail as a modal alternative in the corridor.

- **Train Consist Restrictions**

Amtrak currently prohibits normal operation of single car trains on its line because of problems related to the shunting of track circuits and the performance of the cab signal system. This restriction only applies for the short distance on Amtrak's line between Morrisville and Trenton. By requiring two car trains when only a single car would be needed to serve the estimated ridership, significant additional car miles and related operating expenses are incurred over the entire length of the Cross County route. It also increases the capital costs, requiring twice as many rail cars as needed to handle passengers. This seriously penalizes the cost performance of the Regional Rail alternative and, as discussed above, consumes so much energy as to make the Regional Rail alternative less energy efficient than if its riders continued to drive their cars. Because the Regional Rail alternative offers the significant benefit of direct service to Trenton and thus a greater ability to attract riders, further analysis of the Cross County Metro should explore ways to eliminate the single car train restriction.

CONCLUSION - NEXT STEPS

Using standard FTA cost effectiveness measures, a Cross County Metro service compares favorably with other projects nationwide which have advanced to further stages of planning, analysis, or design. The projected performance also falls within the range of existing SEPTA services. The Cross County Metro offers the opportunity to take advantage of an existing right-of-way to serve the growing demand for inter and intra-suburban travel. Because of dispersed land uses, this is a difficult market to serve with public transportation, but as demonstrated by the operating plan developed during the study, a fixed guideway service coordinated with a network of connecting services and shuttles has the ability to attract a significant number of riders to public transportation. The ability of fixed guideway transportation systems to generate more concentrated (and therefore transit-friendly) patterns of development has been demonstrated by other cities in North America. It is likely that the effectiveness of a Cross County Metro service would grow in the future, thus enhancing its value as a transportation investment for the region, increasing mobility, reducing congestion, improving air quality, reducing energy use, supporting more compact development, and helping to shape a more environmentally sound future.

For the Cross County Metro to become a reality, however, a policy decision to advance to the FTA's required Major Investment Analysis process is required. This study provides the background information and support for such a policy decision.

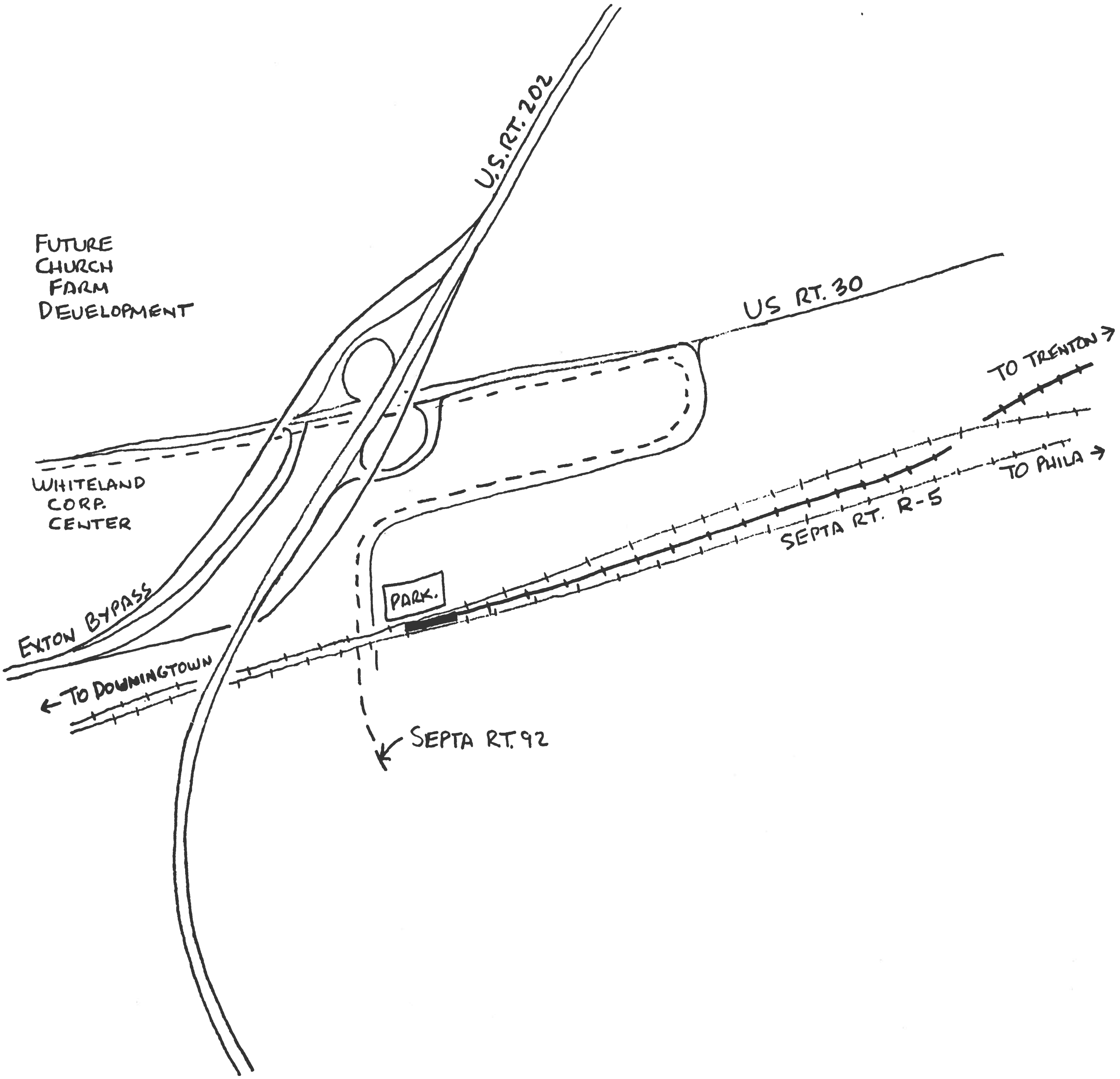
APPENDICES

APPENDIX 1

STATION SCHEMATIC PLANS

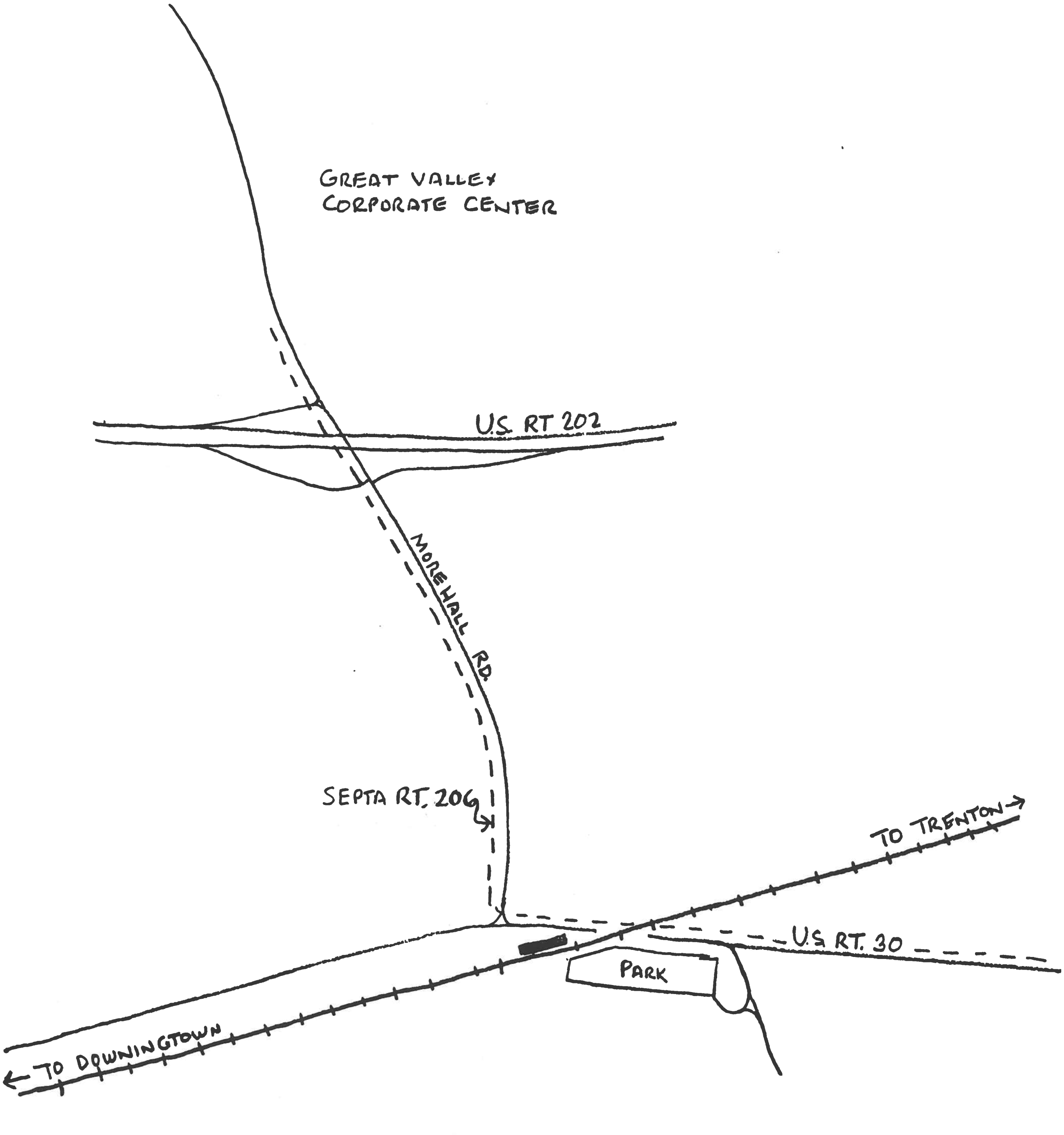
STATION SCHEMATIC PLANS

The following schematic site plans of potential station locations were prepared to illustrate how stations might be accessed from adjacent highways and transit routes. The locations of the stations and the indicated parking areas were selected based on availability of open land as determined from review of aerial photography and access to transit and highway connections. The station locations and layouts should be considered representative only for the purposes of this study; they do not represent a final selection. In subsequent stages of analysis, a more detailed evaluation would be used to evaluate potential sites and designate preferred station locations and layouts.

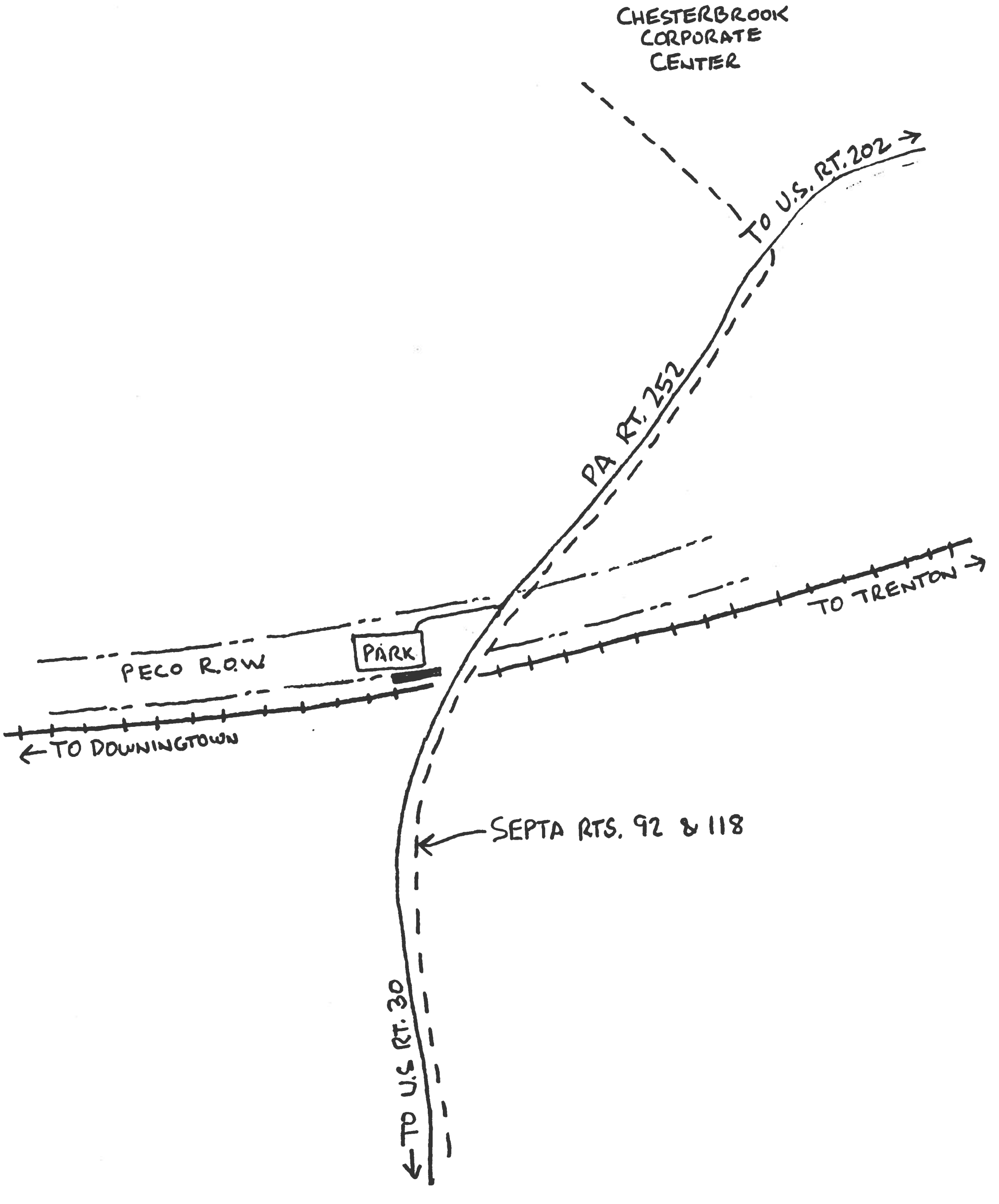


U.S. RT. 202
FUTURE CHURCH FARM DEVELOPMENT
US RT. 30
TO TRENTON →
WHITELAND CORP. CENTER
TO PHILA →
SEPTA RT. R-5
PARK.
EXTON BYPASS
← TO DOWNINGTOWN
SEPTA RT. 92

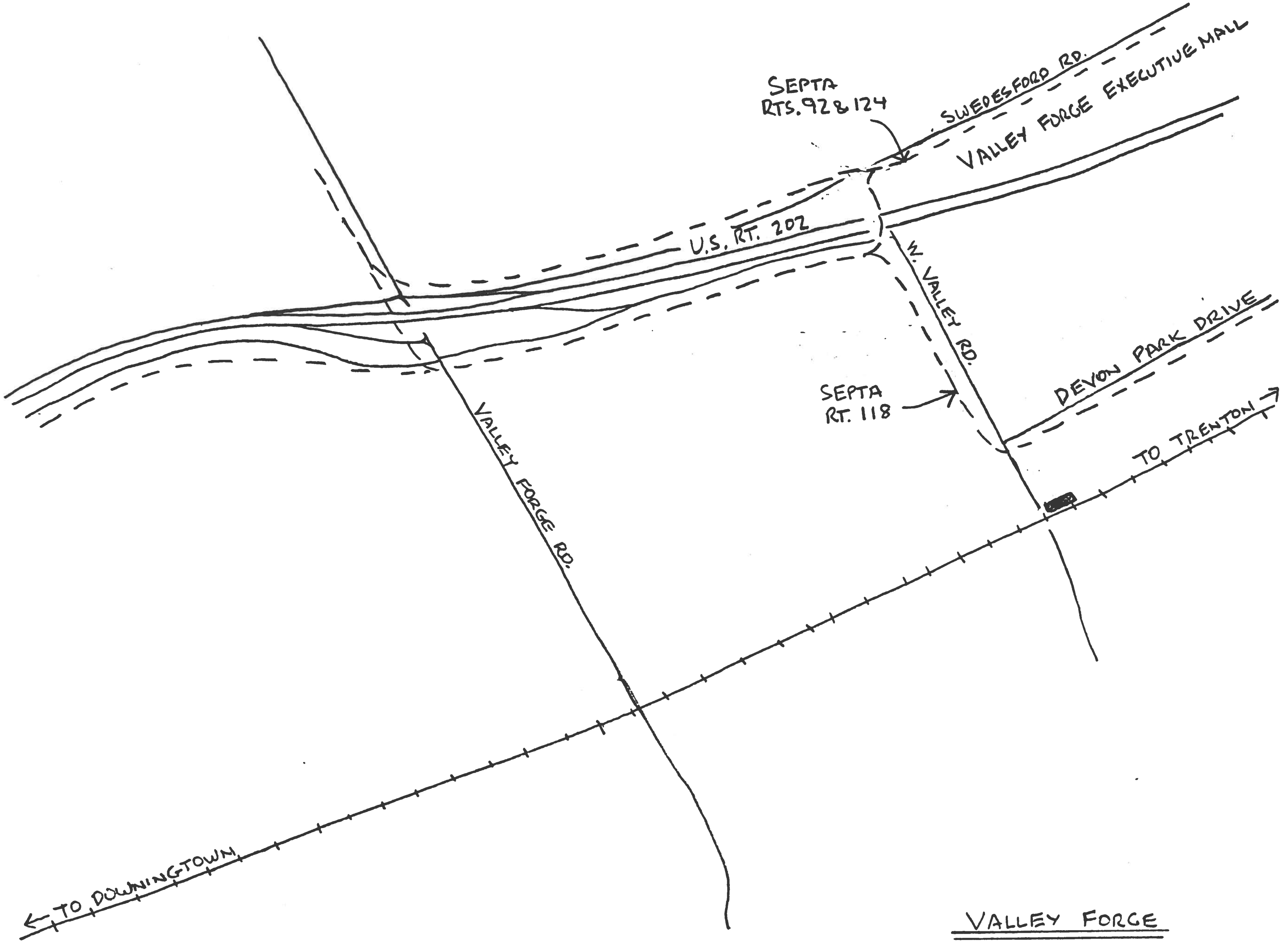
GLENLOCH



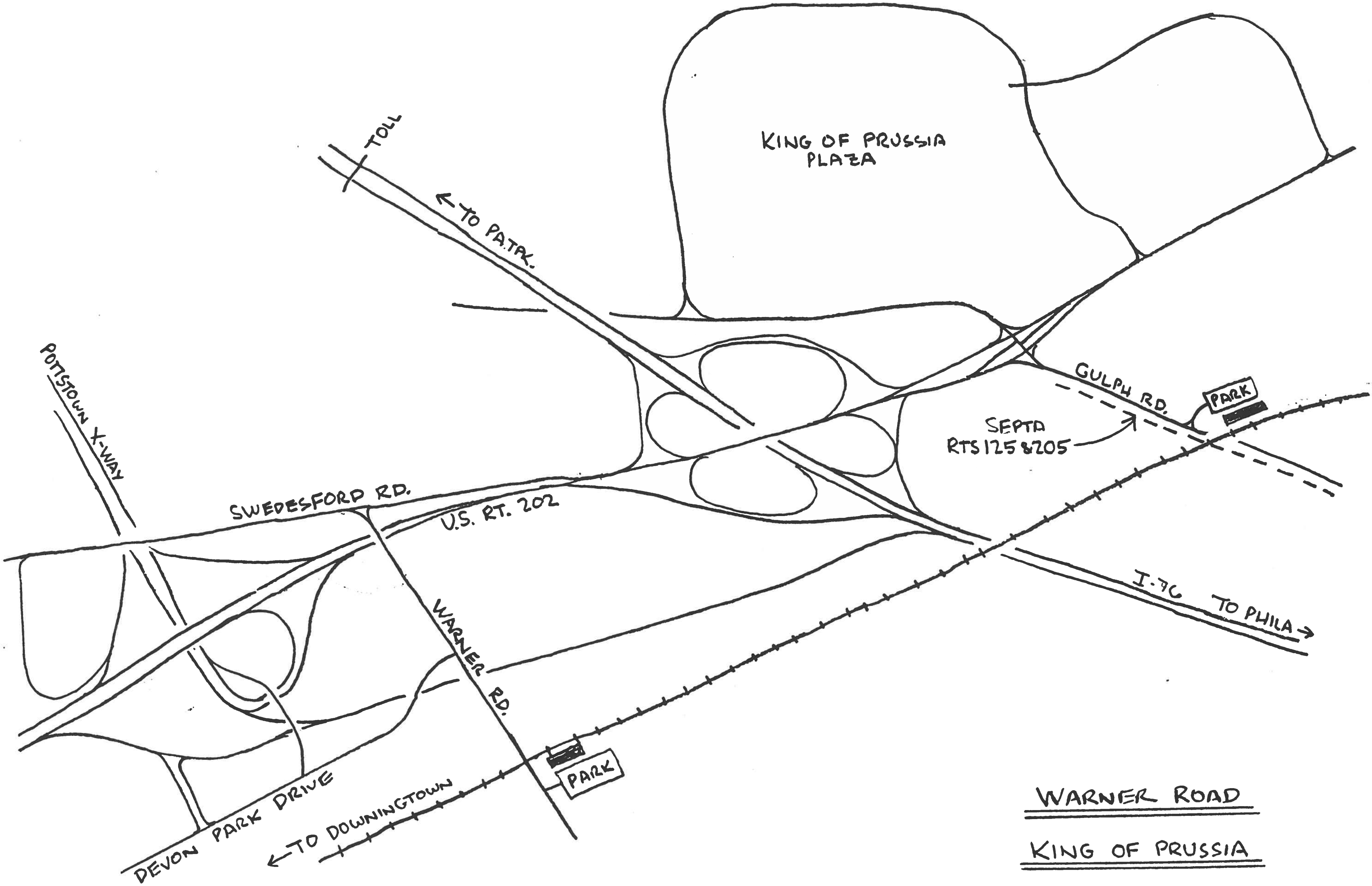
GREAT VALLEY



CHESTERBROOK

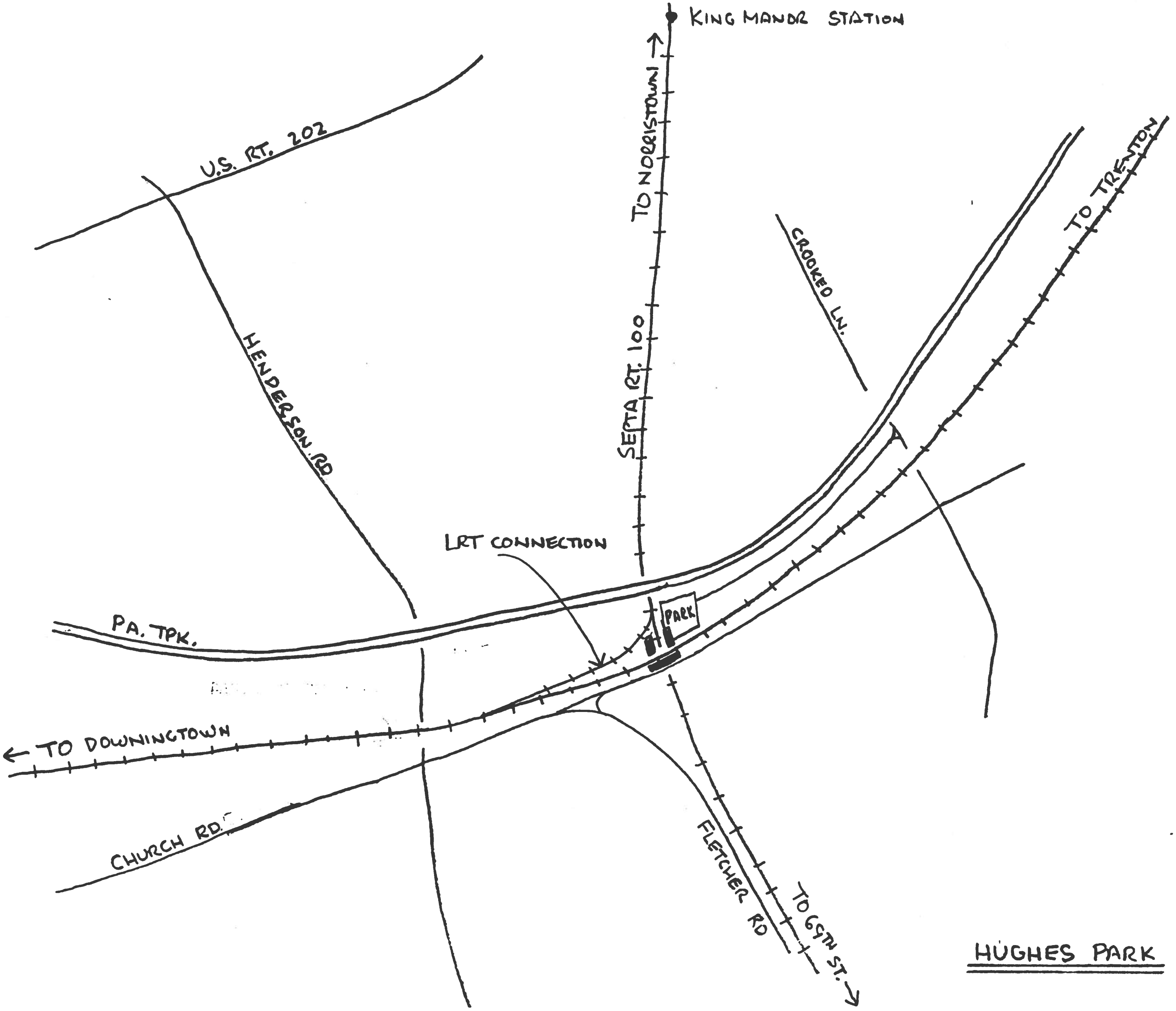


VALLEY FORGE

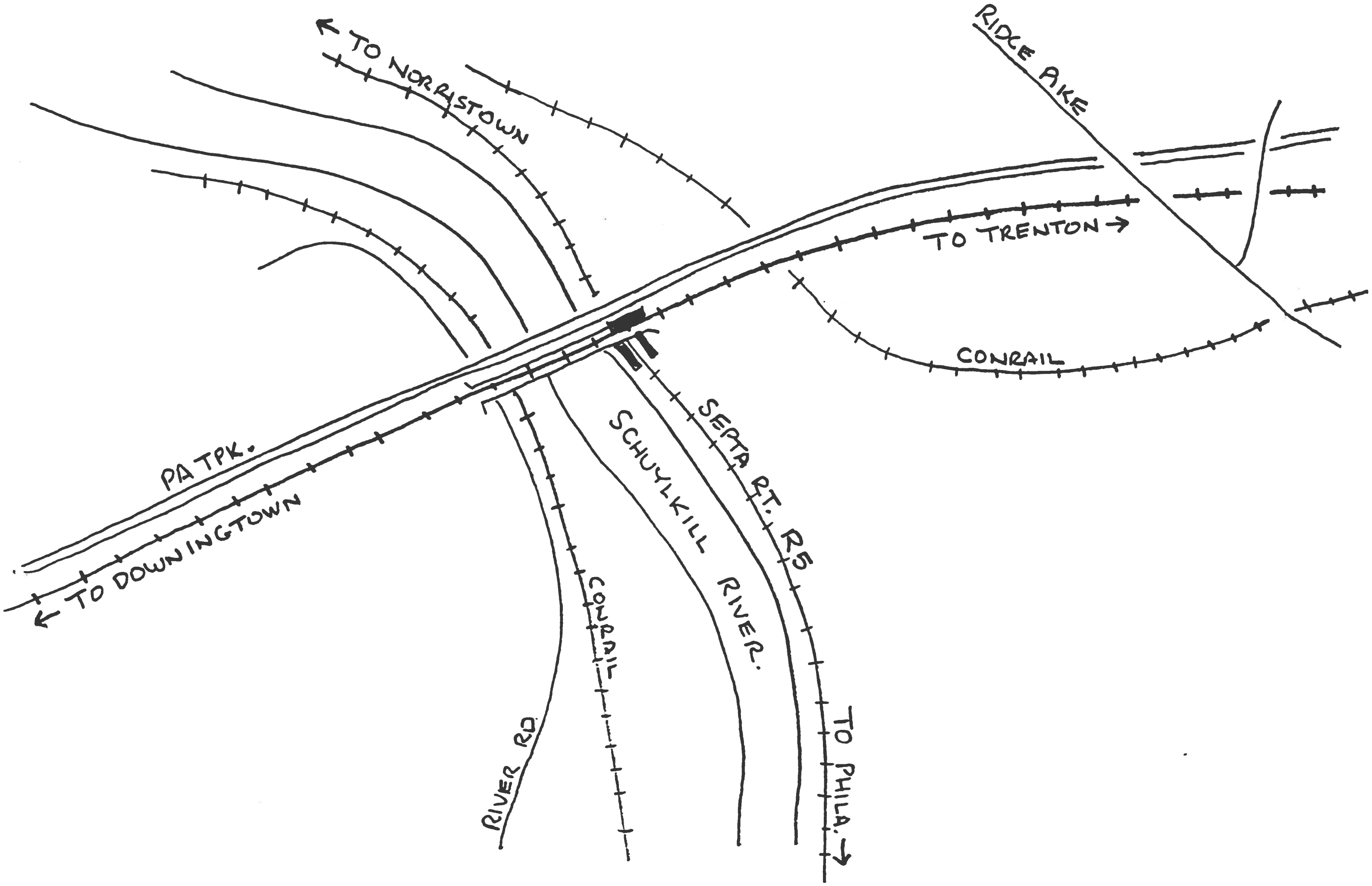


WARNER ROAD

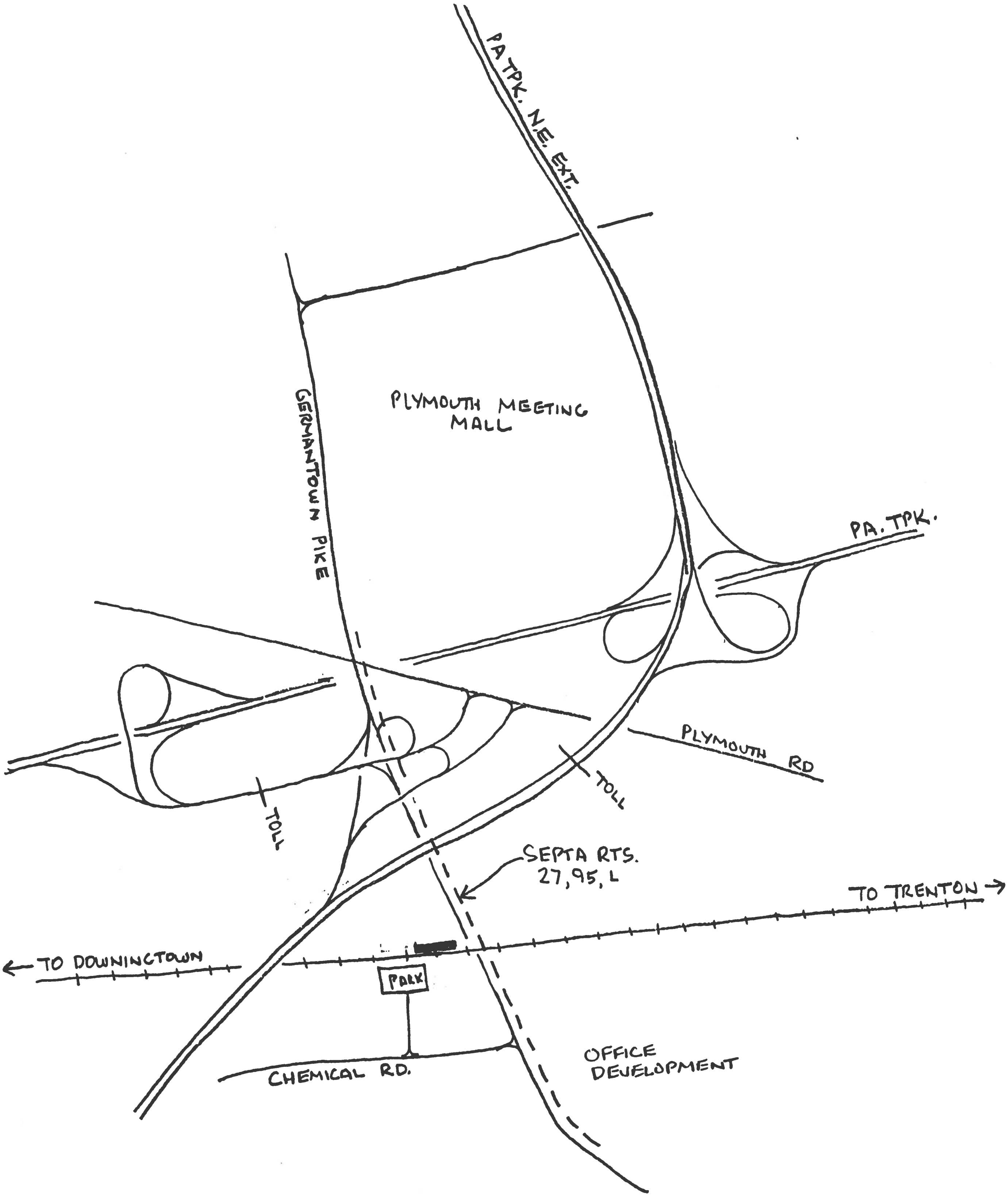
KING OF PRUSSIA


KING MANOR STATION
TO NORRISTOWN
U.S. RT. 202
SEPTA RT. 100
CROOKED LN.
TO TRENTON
HENDERSON RD
LRT CONNECTION
PARK
PA. TPK.
TO DOWNINGTOWN
CHURCH RD.
FLETCHER RD
TO 69TH ST.

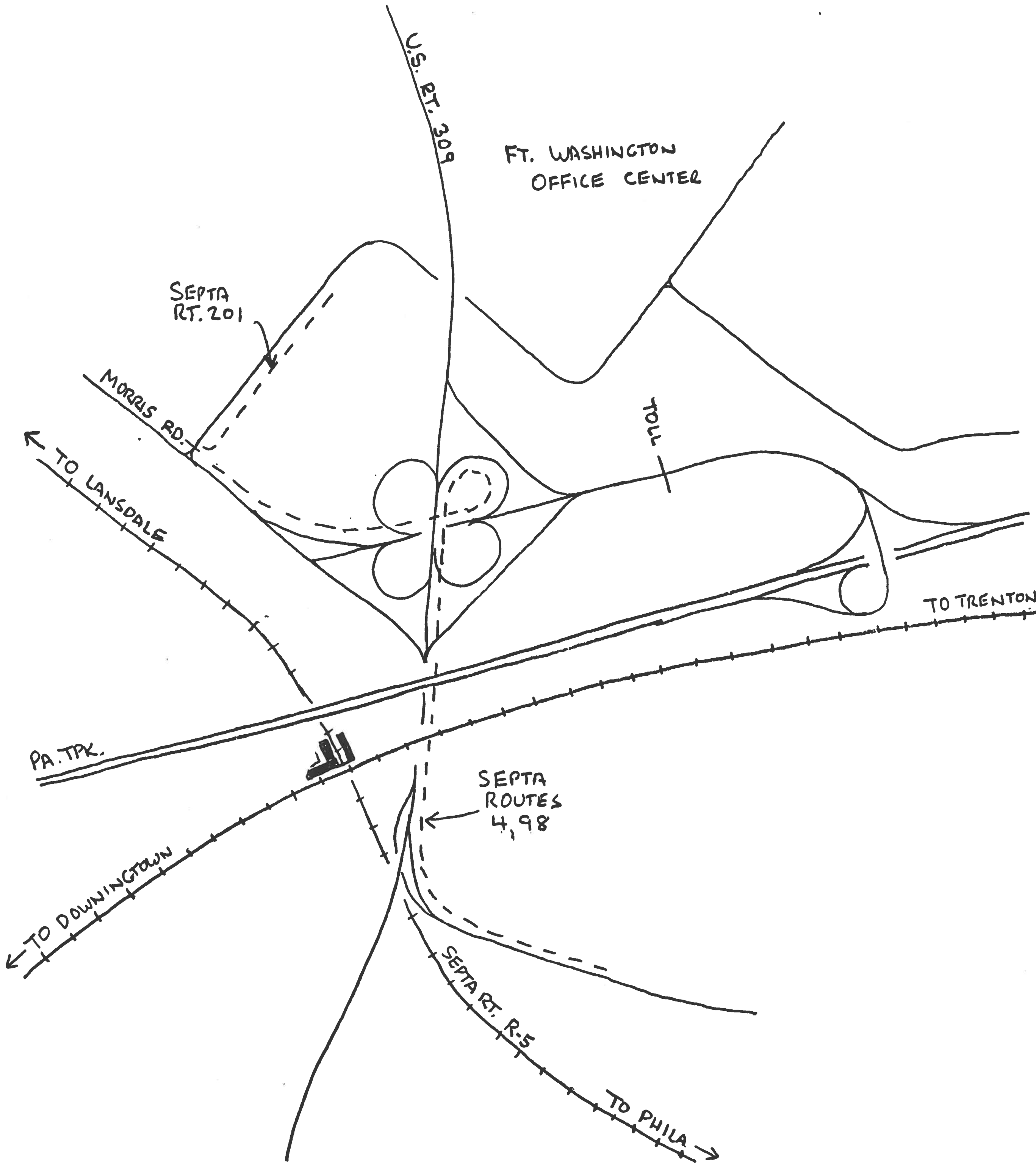
HUGHES PARK


TO NORRISTOWN
RIDGE AVE
TO TRENTON
CONRAIL
PA TPK.
TO DOWNINGTOWN
SEPTA RT. R5
SCHUYLKILL RIVER.
CONRAIL
RIVER RD.
TO PHILA.

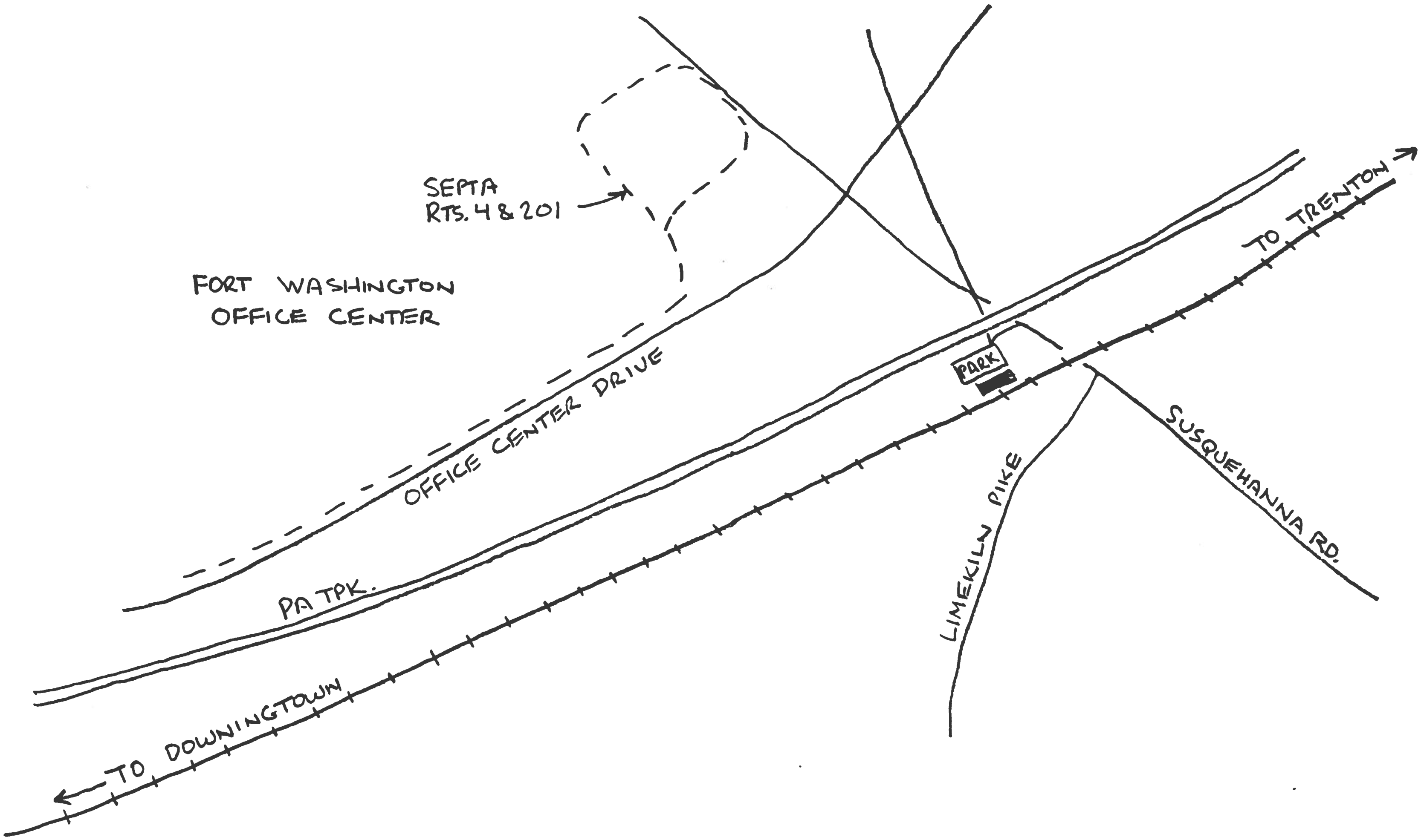
ERNEST



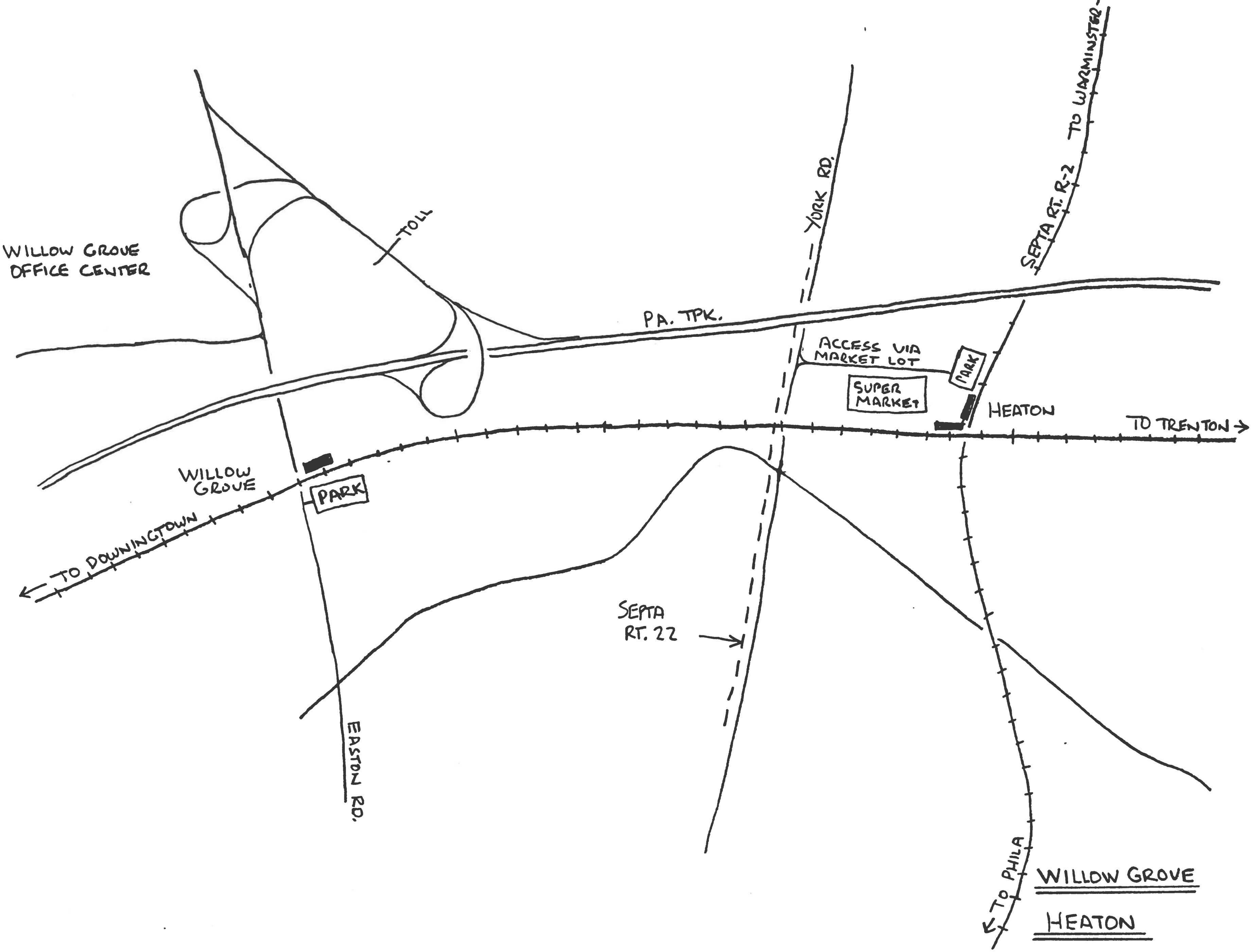
PLYMOUTH MEETING



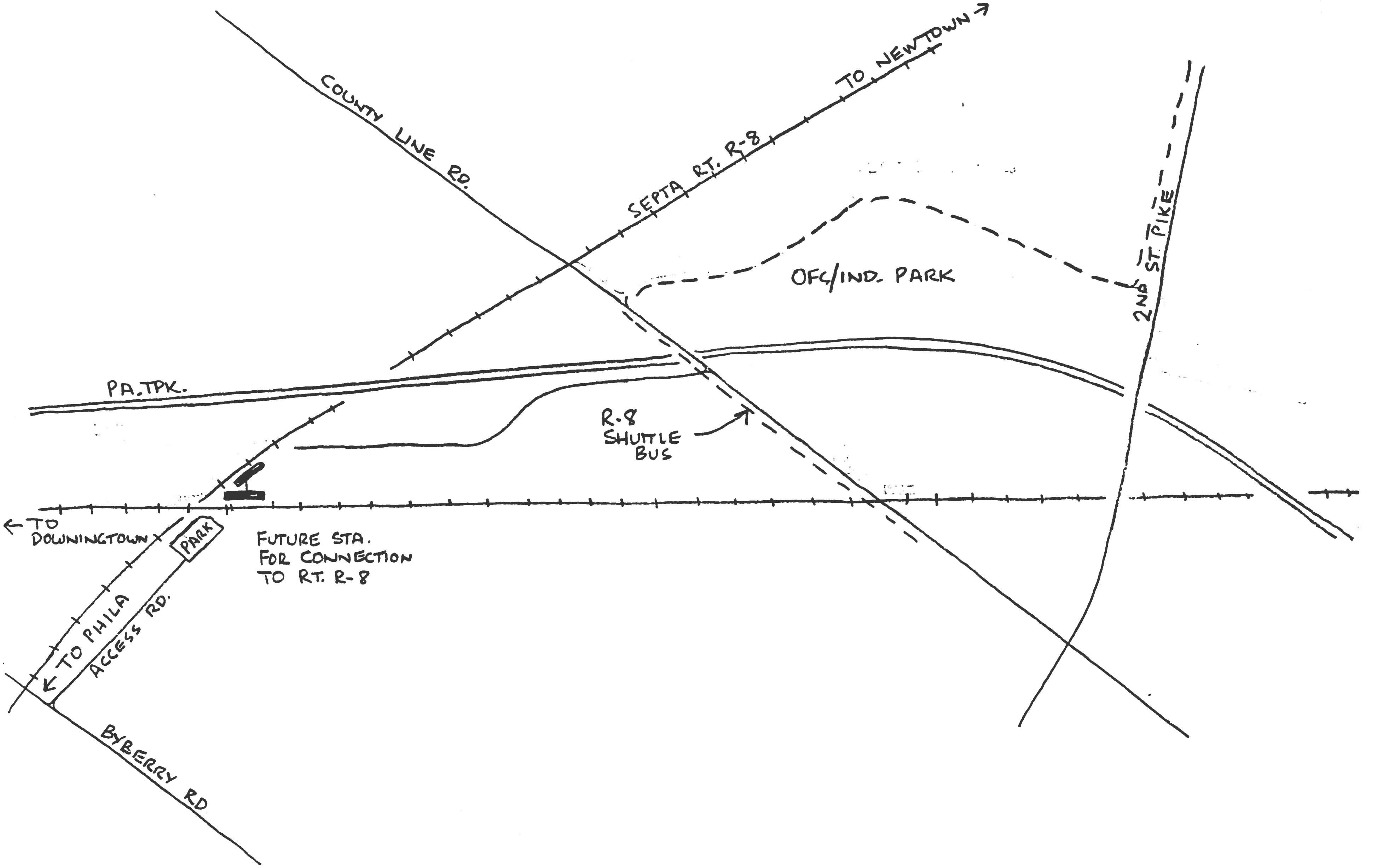
FT. WASHINGTON


SEPTA
RTS. 4 & 201
FORT WASHINGTON
OFFICE CENTER
OFFICE CENTER DRIVE
PA TPK.
PARK
TO TRENTON
TO DOWNINGTOWN
LIMEKILN PIKE
SUSQUEHANNA RD.

DRESHER

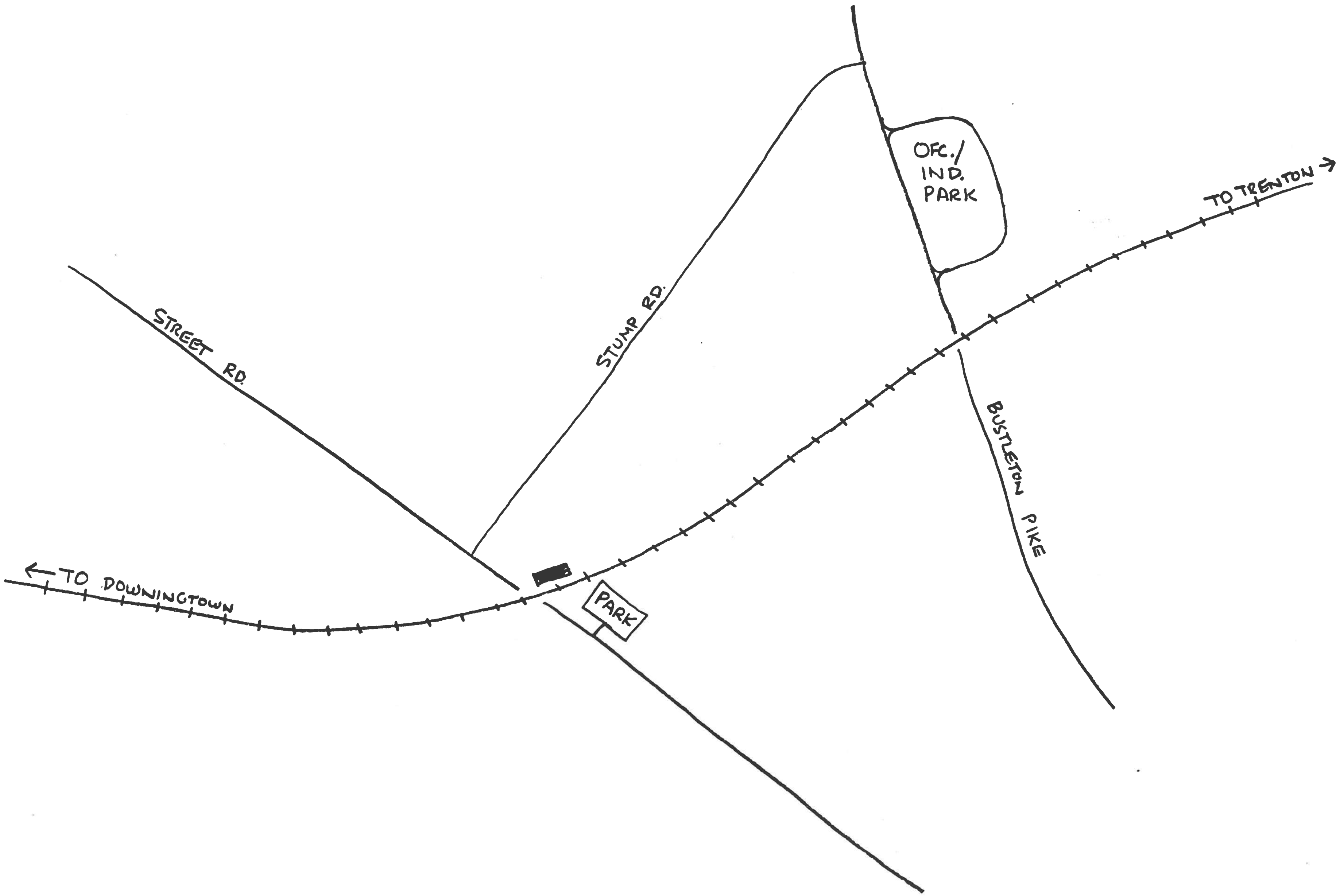


WILLOW GROVE OFFICE CENTER
TOLL
YORK RD.
SEPTA RT. R-2
TO WARMINSTER
PA. TPK.
ACCESS VIA MARKET LOT
PARK
SUPER MARKET
HEATON
TO TRENTON
WILLOW GROVE
PARK
TO DOWNINGTOWN
SEPTA RT. 22
EASTON RD.
TO PHILA
WILLOW GROVE
HEATON

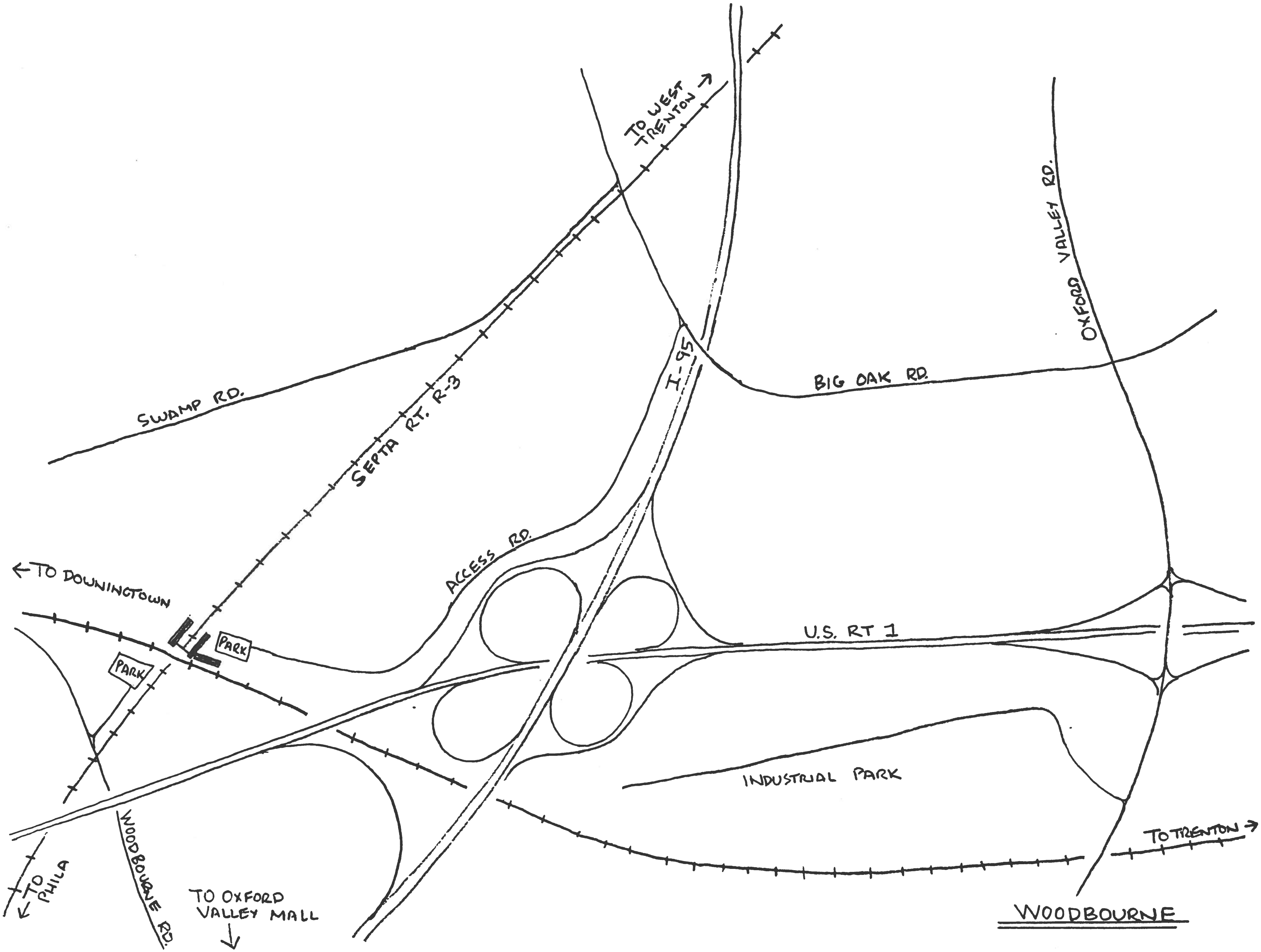


COUNTY LINE RD.
SEPTA RT. R-8
TO NEWTOWN →
2ND ST. PIKE
OFC/IND. PARK
PA. TPK.
R-8 SHUTTLE BUS
← TO DOWNINGTOWN
PARK
FUTURE STA. FOR CONNECTION TO RT. R-8
← TO PHILA
ACCESS RD.
BYBERRY RD

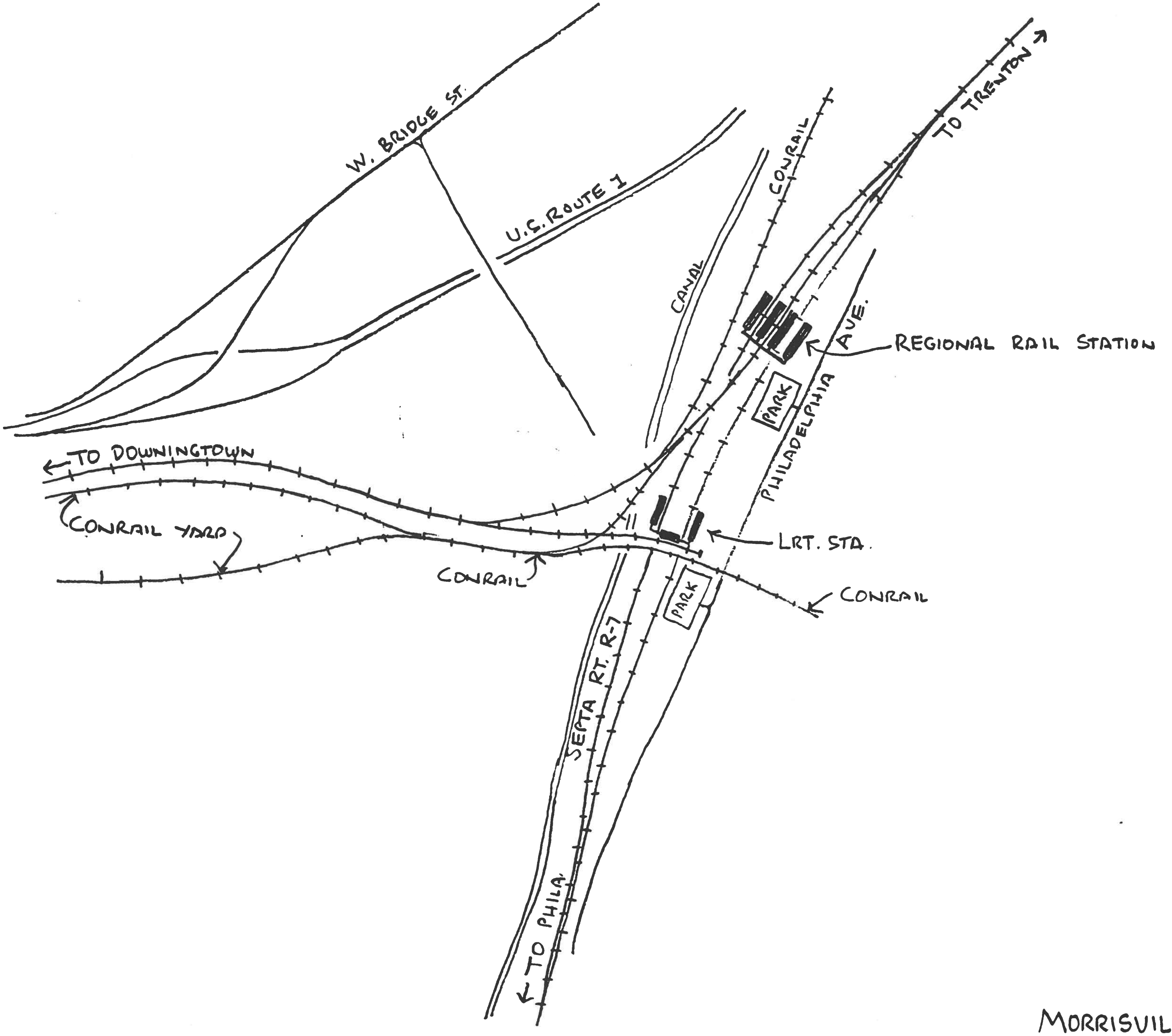
COUNTY LINE



FEASTERVILLE


TO WEST TRENTON →
SWAMP RD.
SEPTA RT. R-3
I-95
BIG OAK RD.
OXFORD VALLEY RD.
ACCESS RD.
← TO DOWNINGTOWN
PARK
PARK
U.S. RT 1
INDUSTRIAL PARK
TO TRENTON →
TO PHILA
WOODBOURNE RD.
TO OXFORD VALLEY MALL

WOODBOURNE



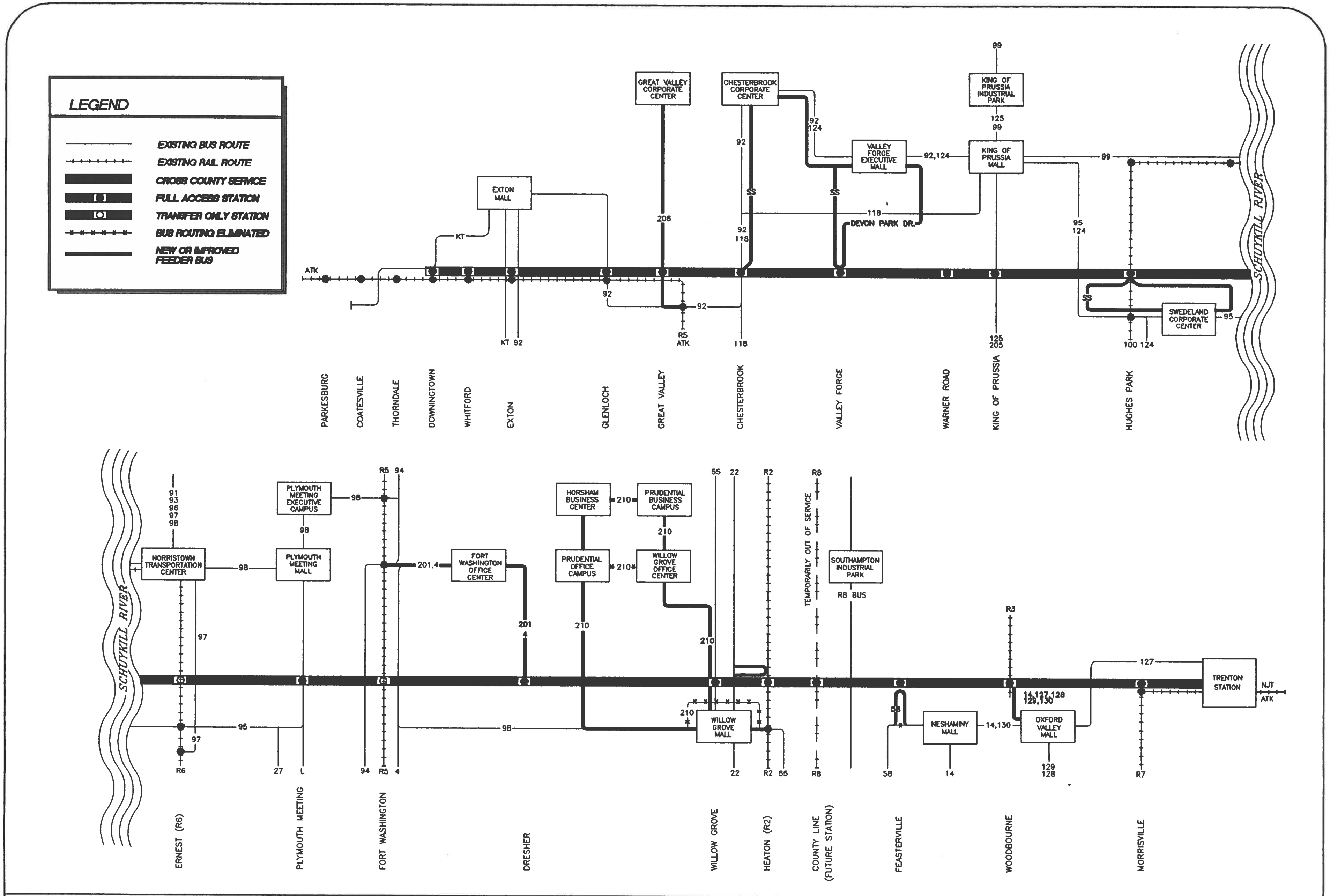
MORRISVILLE

APPENDIX 2

SCHEMATIC MAPS OF ALTERNATIVES AND CONNECTING SERVICES

SCHEMATIC MAPS OF ALTERNATIVES AND CONNECTING SERVICES

The following charts illustrate in schematic form the route structure of each of the four service alternatives evaluated in this study. They illustrate the Cross County corridor service, new and improved connecting services between stations and various employment centers and other traffic generators, and other existing intersecting bus and rail transit routes. The specific routings, headways, and connecting points were used by the mode split model in estimating transit travel times, transit ridership, and network assignments. The route structures also served as the basis for estimating operating and maintenance costs and capital costs. The headways for all routes shown are tabulated in Appendix D of the separate Technical Appendix.



Urban Engineers, Inc.
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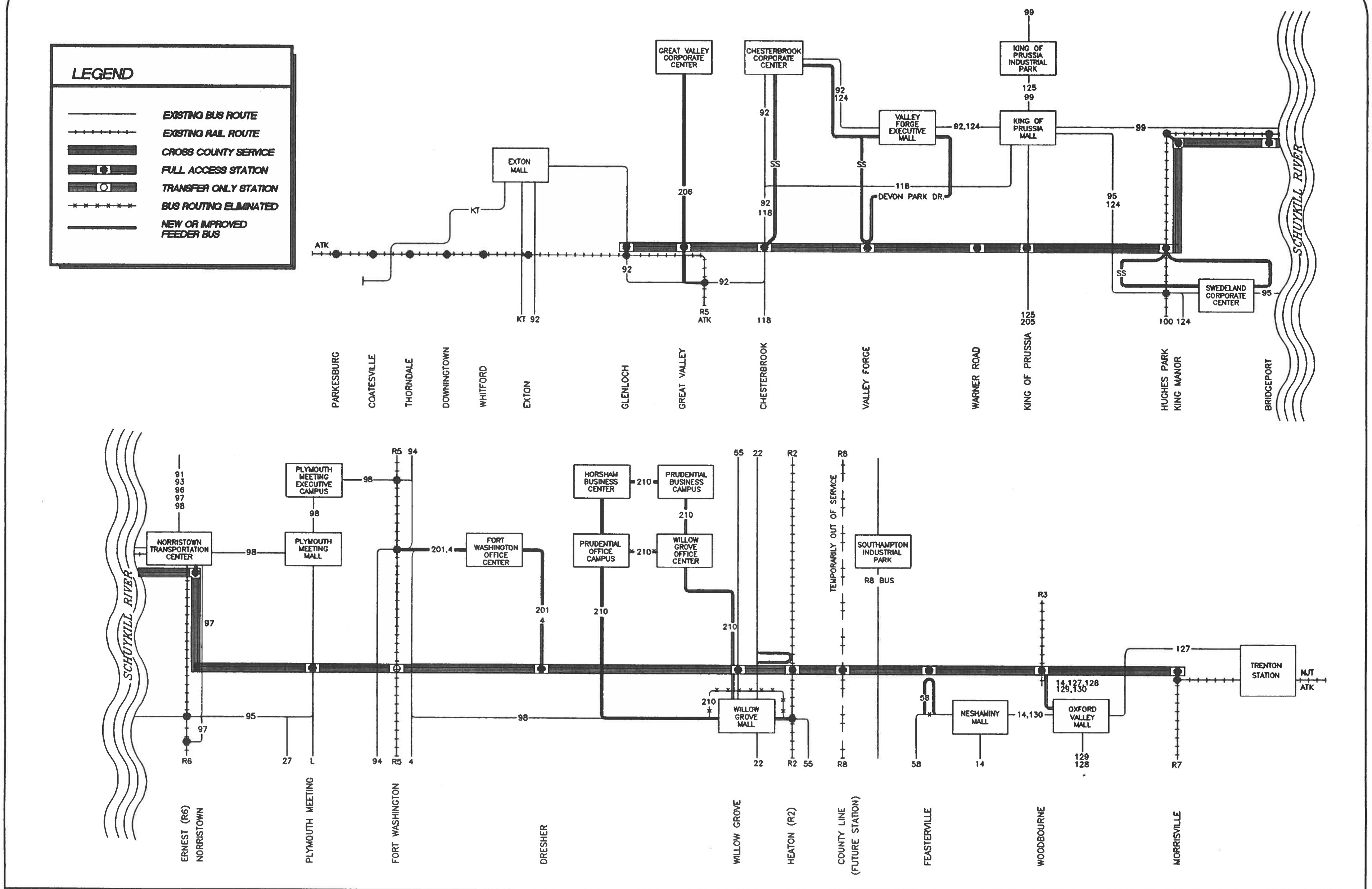
Philadelphia, PA 19106-1193

Cross County Metro

SCHEMATIC DIAGRAM CROSS COUNTY REGIONAL RAIL AND CONNECTING SERVICES

Figure No.
4 - 4



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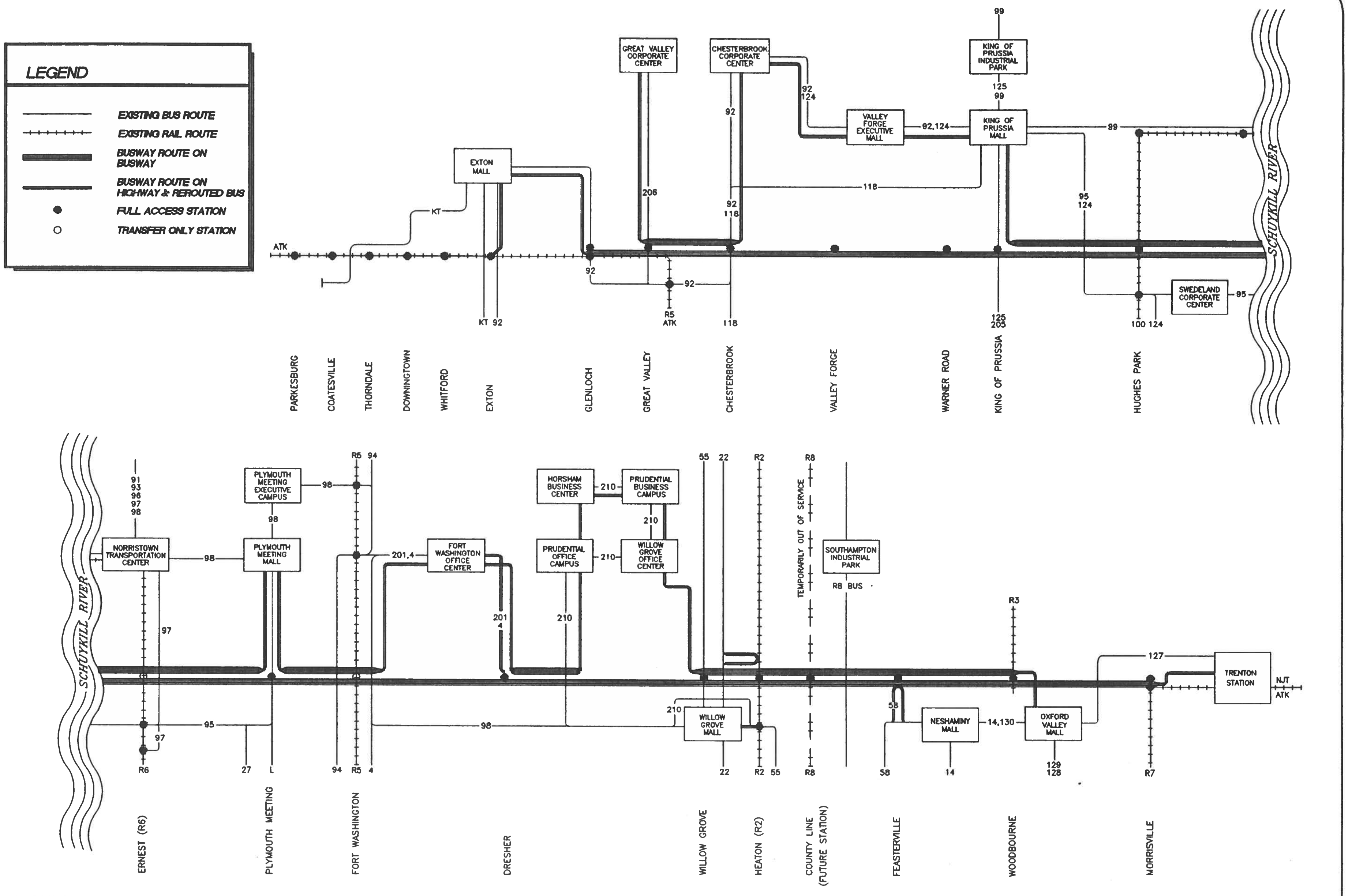
Cross County Metro

SCHEMATIC DIAGRAM
CROSS COUNTY LIGHT RAIL
AND CONNECTING SERVICES

Figure No.
4 - 5



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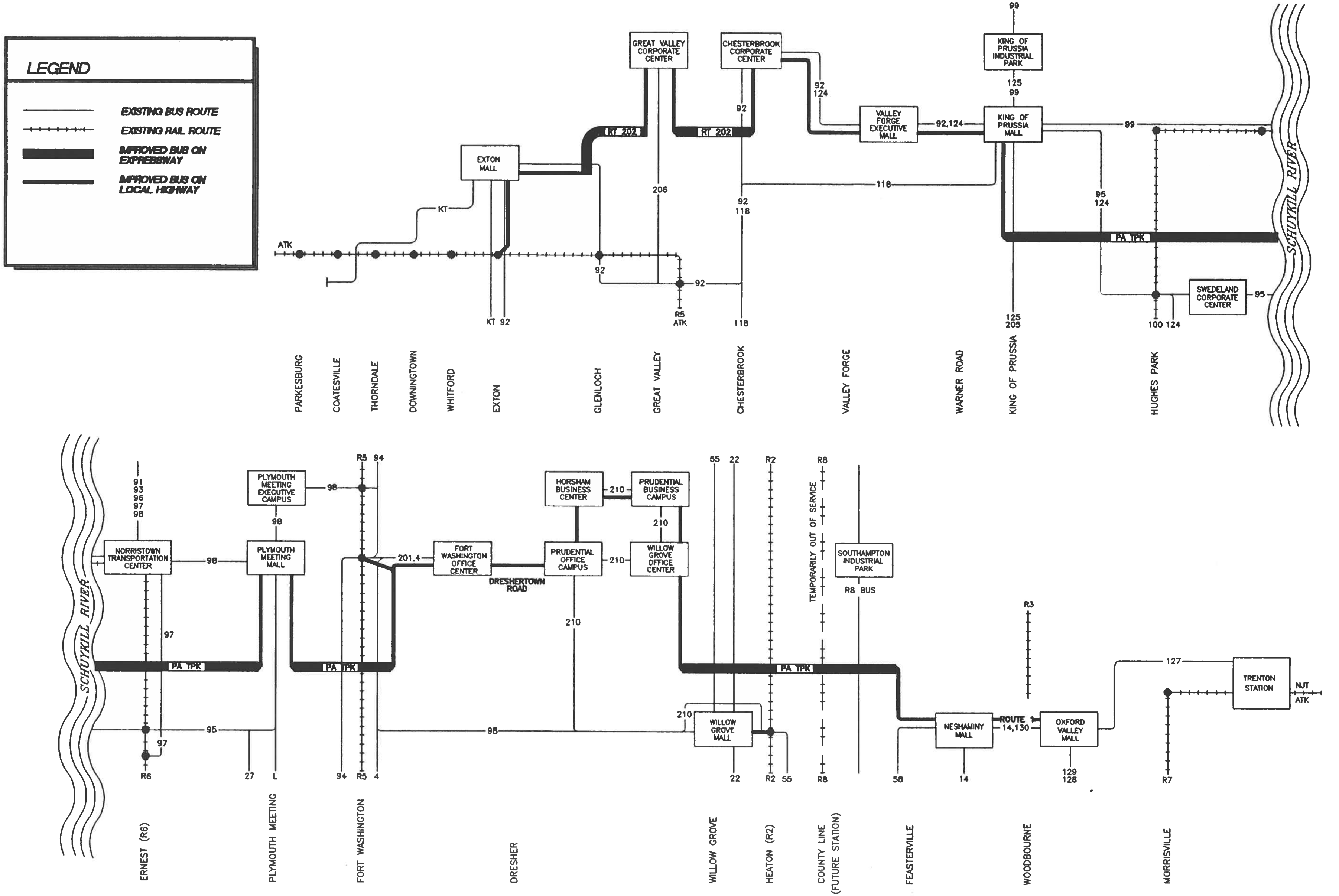
Cross County Metro

SCHEMATIC DIAGRAM
CROSS COUNTY BUSWAY
AND CONNECTING SERVICES

Figure No.
4 - 6



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Cross County Metro

SCHEMATIC DIAGRAM
CROSS COUNTY IMPROVED BUS
AND CONNECTING SERVICES

Figure No.
4 - 7

APPENDIX 3

CASH FLOW ANALYSIS

CASH FLOW ANALYSIS

Exhibits 3-1 through 3-4 illustrate preliminary estimates for cash flow analyses of the existing SEPTA budgets with the addition of the improved bus, busway, regional rail and light rail alternatives. Operating and expense data for the existing system was obtained from SEPTA's Fiscal Year 1994 Operating Budget and combined with the operating and maintenance, capital costs and operating revenues for the proposed alternatives. A potential funding scenario labeled Revenue Available for Capital is included in each cash flow statement to illustrate the 80% Federal and 20% Local/State funding levels. In addition, Federal subsidies were increased for new rail and bus service using the allocation formula for Section 9 funds in urbanized areas above 200,000 in population as outlined in the Section 15 Annual Report. For example the following allocation formula was utilized for the rail alternatives:

Rail Tier	**33.29% of $27.2 million (1993 Subsidy) = $9.1 million**
Base portion	95.61% of $9.1 million = $8.7 million
Revenue vehicle miles	60.00% of $8.7 million = $5.2 million
Route miles	40.00% of $8.7 million = $3.5 million
Incentive portion	4.39% of $9.1 million = $0.4 million

The Light Rail alternative will increase the Section 9 subsidy by approximately $0.7 million and the Regional Rail alternative will generate an additional subsidy of approximately $1.0 million. Additional Section 9 subsidies for both the Improved Bus and Busway alternatives is approximately $0.6 million. These amounts have been added to the Federal subsidy line items beginning in the year 2000 for each of the cash flow statements.

Exhibits 3-1 through 3-4 provide hypothetical cash flow statements for each of the proposed alternatives. It should be noted that these cash flow statements are not intended to present the expected scenario that will occur with the construction and operation of an alternative, but instead represent a preliminary estimate of expenses and revenues to provide insight into the possible effects of a new service. Operating revenue was estimated for each new alternative based on the average fare for similar existing SEPTA service and estimated ridership, and included under New Operation Revenue beginning in FY 2001 which is the estimated start of revenue operations. Operating and maintenance costs for each alternative are based on the cost models discussed in Chapter 5 and are included just below total operating expense on each exhibit. These costs were inflated at 4% per year following the estimated revenue operation start date of FY 2001. The capital cost for each alternative is listed under Capital Expenditures beginning in Fiscal Year 1996 which is the assumed start date of project design and construction. The capital cost for each alternative was inflated from Fiscal Year 1993 to fiscal year 1996 by the 4% inflation rate and divided equally into the five year design and construction period. The revenue needed to design and construct the preferred alternative is included under Revenue Available for Capital. Federal funds will account for 80% of the needed capital and can be issued through Section 3, Flexible Funding and Section 9 programs. Dollar amounts were not included in any of these line items because there is no certainty as to which funding program or combination of programs will provide the 80% portion of Federal funds. For the purpose of these potential cash flow scenarios it was assumed that the Federal portion will be 80% and the Local/State sources will provide the remaining 20% of project funding. As a result, the revenue needed to fund the alternative was simply determined by these percentages of the capital expenditures for that particular fiscal year. For example, capital expenditures in FY 1996 for the improved bus alternative are $2.9 million resulting in $2.3 million in Federal funding (80%) and $0.6 million in Local/State funding (20%).

Exhibit 3-1

Summary Of SEPTA Current And Projected Cash Flow With Improved Bus Alternative

Current $ Million

Fiscal Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Operating Revenue													
Farebox Revenue	$253.6	$264.5	$272.0	$282.9	$294.2	$306.0	$318.2	$330.9	$344.2	$357.9	$372.3	$387.3	$3,784.0
New Operation Revenue	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.7	$0.8	$0.8	$0.8	$3.1
Other Operating Revenue	57.2	58.4	60.7	63.2	65.7	68.3	71.1	73.9	76.9	79.9	83.1	$86.4	$844.8
Total Operating Revenue	$310.8	$322.9	$332.7	$346.1	$359.9	$374.3	$389.3	$404.8	$421.8	$438.6	$456.2	$474.5	$4,631.9
Non-Operating Revenue													
Federal Subsidy	$27.2	$27.2	$28.3	$29.4	$30.6	$31.8	$33.1	$34.4	$36.4	$37.8	$39.3	$41.5	$397.0
State Subsidy	$163.1	$166.5	$180.6	$186.4	$195.2	$204.2	$213.6	$223.4	$232.9	$242.2	$251.9	$262.0	$2,522.0
Local Subsidy	$55.7	$55.5	$60.2	$62.1	$65.1	$68.2	$71.2	$74.5	$77.6	$80.7	$83.9	$87.2	$841.9
State/Local Asset Maint.	$31.2	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$42.6	$44.3	$46.1	$47.9	$503.2
Other Income	10.8	13.6	14.0	14.7	15.3	15.8	16.4	17.2	17.7	18.6	19.3	$20.0	$193.4
Total Non-Operating Revenue	$288.0	$304.4	$324.7	$334.2	$347.8	$361.6	$375.9	$391.1	$407.2	$423.6	$440.5	$458.6	$4,457.5
Total Revenue	$598.8	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$829.0	$862.2	$896.6	$933.1	$9,089.5
Operating & Maintenance Expenses													
Labor & Fringe	$434.2	$434.5	$460.5	$479.0	$498.1	$518.1	$538.8	$560.3	$582.7	$606.0	$630.3	$655.6	$6,398.1
Materials & Service	$98.7	$101.8	$105.9	$110.1	$114.5	$119.1	$123.8	$128.8	$133.9	$139.3	$144.9	$150.7	$1,471.5
Injuries & Damage	$40.0	$38.0	$36.0	$34.0	$35.4	$36.8	$38.2	$39.8	$41.4	$43.0	$44.7	$46.5	$473.8
Propulsion Power	$25.2	$26.9	$27.9	$29.1	$30.2	$31.4	$32.7	$34.0	$35.4	$36.8	$38.2	$39.7	$387.5
Fuel	$9.7	$9.6	$10.0	$10.4	$10.8	$11.3	$11.7	$12.2	$12.7	$13.2	$13.7	$14.3	$139.7
Other Operating	($6.3)	$16.4	$17.1	$17.7	$18.5	$19.2	$20.0	$20.8	$21.6	$22.5	$23.4	$24.4	$215.4
Total Operating Expense	$601.5	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$827.7	$860.8	$895.3	$931.1	$9,086.1
Improved Bus	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$7.0	$7.3	$7.5	$7.9	$29.6
Balance From Operations	($2.7)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	($5.6)	($5.9)	($6.2)	($5.9)	($26.2)
Revenue Available For Capital													
Section 3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Flexible Funding	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Section 9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total Federal	$0.0	$0.0	$0.0	$2.3	$2.4	$2.5	$2.6	$2.7	$0.0	$0.0	$0.0	$0.0	$12.5
Local / State	$0.0	$0.0	$0.0	$0.6	$0.6	$0.6	$0.7	$0.7	$0.0	$0.0	$0.0	$0.0	$3.1
Total Capital Revenue	$0.0	$0.0	$0.0	$2.9	$3.0	$3.1	$3.3	$3.4	$0.0	$0.0	$0.0	$0.0	$15.7
Capital Expenditures													
Improved Bus	$0.0	$0.0	$0.0	$2.9	$3.0	$3.1	$3.3	$3.4	$0.0	$0.0	$0.0	$0.0	$15.7
Subtotal For Rail System	$0.0	$0.0	$0.0	$2.9	$3.0	$3.1	$3.3	$3.4	$0.0	$0.0	$0.0	$0.0	$15.7
Operating & Capital Balance	($2.7)	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1	$0.1	($5.6)	($11.5)	($17.7)	($23.5)	

Exhibit 3-2

Summary Of SEPTA Current And Projected Cash Flow With Busway Alternative

Current $ Million

Fiscal Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Operating Revenue													
Farebox Revenue	$253.6	$264.5	$272.0	$282.9	$294.2	$306.0	$318.2	$330.9	$344.2	$357.9	$372.3	$387.3	$3,784.0
New Operation Revenue	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$3.1	$3.2	$3.4	$3.5	$13.2
Other Operating Revenue	57.2	58.4	60.7	63.2	65.7	68.3	71.1	73.9	76.9	79.9	83.1	$86.4	$844.8
Total Operating Revenue	$310.8	$322.9	$332.7	$346.1	$359.9	$374.3	$389.3	$404.8	$424.2	$441.0	$458.8	$477.2	$4,642.1
Non-Operating Revenue													
Federal Subsidy	$27.2	$27.2	$28.3	$29.4	$30.6	$31.8	$33.1	$34.4	$36.5	$37.9	$39.4	$41.7	$397.5
State Subsidy	$163.1	$166.5	$180.6	$186.4	$195.2	$204.2	$213.6	$223.4	$232.9	$242.2	$251.9	$262.0	$2,522.0
Local Subsidy	$55.7	$55.5	$60.2	$62.1	$65.1	$68.2	$71.2	$74.5	$77.6	$80.7	$83.9	$87.2	$841.9
State/Local Asset Maint.	$31.2	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$42.6	$44.3	$46.1	$47.9	$503.2
Other Income	10.8	13.6	14.0	14.7	15.3	15.8	16.4	17.2	17.7	18.6	19.3	$20.0	$193.4
Total Non-Operating Revenue	$288.0	$304.4	$324.7	$334.2	$347.8	$361.6	$375.9	$391.1	$407.3	$423.7	$440.6	$458.8	$4,458.0
Total Revenue	$598.8	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$831.5	$864.7	$899.3	$936.0	$9,100.1
Operating & Maintenance Expenses													
Labor & Fringe	$434.2	$434.5	$460.5	$479.0	$498.1	$518.1	$538.8	$560.3	$582.7	$606.0	$630.3	$655.6	$6,398.1
Materials & Service	$98.7	$101.8	$105.9	$110.1	$114.5	$119.1	$123.8	$128.8	$133.9	$139.3	$144.9	$150.7	$1,471.5
Injuries & Damage	$40.0	$38.0	$36.0	$34.0	$35.4	$36.8	$38.2	$39.8	$41.4	$43.0	$44.7	$46.5	$473.8
Propulsion Power	$25.2	$26.9	$27.9	$29.1	$30.2	$31.4	$32.7	$34.0	$35.4	$36.8	$38.2	$39.7	$387.5
Fuel	$9.7	$9.6	$10.0	$10.4	$10.8	$11.3	$11.7	$12.2	$12.7	$13.2	$13.7	$14.3	$139.7
Other Operating	($6.3)	$16.4	$17.1	$17.7	$18.5	$19.2	$20.0	$20.8	$21.6	$22.5	$23.4	$24.4	$215.4
Total Operating Expense	$601.5	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$827.7	$860.8	$895.3	$931.1	$9,086.1
Busway Alternative	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$7.8	$8.1	$8.4	$8.8	$33.1
Balance From Operations	($2.7)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	($4.0)	($4.2)	($4.4)	($3.9)	($19.1)
Revenue Available For Capital													
Section 3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Flexible Funding	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Section 9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total Federal	$0.0	$0.0	$0.0	$85.7	$89.2	$92.7	$96.4	$100.3	$0.0	$0.0	$0.0	$0.0	$464.3
Local / State	$0.0	$0.0	$0.0	$21.4	$22.3	$23.2	$24.1	$25.1	$0.0	$0.0	$0.0	$0.0	$116.1
Total Capital Revenue	$0.0	$0.0	$0.0	$107.2	$111.4	$115.9	$120.5	$125.4	$0.0	$0.0	$0.0	$0.0	$580.4
Capital Expenditures													
Busway	$0.0	$0.0	$0.0	$107.2	$111.4	$115.9	$120.5	$125.4	$0.0	$0.0	$0.0	$0.0	$580.4
Subtotal For Rail System	$0.0	$0.0	$0.0	$107.2	$111.4	$115.9	$120.5	$125.4	$0.0	$0.0	$0.0	$0.0	$580.4
Operating & Capital Balance	($2.7)	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1	$0.1	($3.9)	($8.1)	($12.5)	($16.4)	

Exhibit 3-3

Summary Of SEPTA Current And Projected Cash Flow With Light Rail Alternative

Current $ Million

Fiscal Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Operating Revenue													
Farebox Revenue	$253.6	$264.5	$272.0	$282.9	$294.2	$306.0	$318.2	$330.9	$344.2	$357.9	$372.3	$387.3	$3,784.0
New Operation Revenue	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$5.6	$5.8	$6.1	$6.3	$23.8
Other Operating Revenue	57.2	58.4	60.7	63.2	65.7	68.3	71.1	73.9	76.9	79.9	83.1	$86.4	$844.8
Total Operating Revenue	$310.8	$322.9	$332.7	$346.1	$359.9	$374.3	$389.3	$404.8	$426.7	$443.6	$461.5	$480.0	$4,652.6
Non-Operating Revenue													
Federal Subsidy	$27.2	$27.2	$28.3	$29.4	$30.6	$31.8	$33.1	$35.4	$36.8	$38.2	$39.7	$42.3	$400.0
State Subsidy	$163.1	$166.5	$180.6	$186.4	$195.2	$204.2	$213.6	$223.4	$232.9	$242.2	$251.9	$262.0	$2,522.0
Local Subsidy	$55.7	$55.5	$60.2	$62.1	$65.1	$68.2	$71.2	$74.5	$77.6	$80.7	$83.9	$87.2	$841.9
State/Local Asset Maint.	$31.2	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$42.6	$44.3	$46.1	$47.9	$503.2
Other Income	10.8	13.6	14.0	14.7	15.3	15.8	16.4	17.2	17.7	18.6	19.3	$20.0	$193.4
Total Non-Operating Revenue	$288.0	$304.4	$324.7	$334.2	$347.8	$361.6	$375.9	$392.1	$407.6	$424.0	$440.9	$459.4	$4,460.5
Total Revenue	$598.8	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$796.9	$834.3	$867.6	$902.3	$939.4	$9,113.2
Operating & Maintenance Expenses													
Labor & Fringe	$434.2	$434.5	$460.5	$479.0	$498.1	$518.1	$538.8	$560.3	$582.7	$606.0	$630.3	$655.6	$6,398.1
Materials & Service	$98.7	$101.8	$105.9	$110.1	$114.5	$119.1	$123.8	$128.8	$133.9	$139.3	$144.9	$150.7	$1,471.5
Injuries & Damage	$40.0	$38.0	$36.0	$34.0	$35.4	$36.8	$38.2	$39.8	$41.4	$43.0	$44.7	$46.5	$473.8
Propulsion Power	$25.2	$26.9	$27.9	$29.1	$30.2	$31.4	$32.7	$34.0	$35.4	$36.8	$38.2	$39.7	$387.5
Fuel	$9.7	$9.6	$10.0	$10.4	$10.8	$11.3	$11.7	$12.2	$12.7	$13.2	$13.7	$14.3	$139.7
Other Operating	($6.3)	$16.4	$17.1	$17.7	$18.5	$19.2	$20.0	$20.8	$21.6	$22.5	$23.4	$24.4	$215.4
Total Operating Expense	$601.5	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$827.7	$860.8	$895.3	$931.1	$9,086.1
Light Rail Alternative	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$9.7	$10.1	$10.5	$10.9	$41.3
Balance From Operations	($2.7)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.0	($3.1)	($3.3)	($3.5)	($2.7)	($14.2)
Revenue Available For Capital													
Section 3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Flexible Funding	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Section 9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total Federal	$0.0	$0.0	$0.0	$63.0	$65.6	$68.2	$70.9	$73.8	$0.0	$0.0	$0.0	$0.0	$341.5
Local / State	$0.0	$0.0	$0.0	$15.8	$16.4	$17.0	$17.7	$18.4	$0.0	$0.0	$0.0	$0.0	$85.4
Total Capital Revenue	$0.0	$0.0	$0.0	$78.8	$82.0	$85.2	$88.7	$92.2	$0.0	$0.0	$0.0	$0.0	$426.9
Capital Expenditures													
Light Rail	$0.0	$0.0	$0.0	$78.8	$82.0	$85.2	$88.7	$92.2	$0.0	$0.0	$0.0	$0.0	$426.9
Subtotal For Rail System	$0.0	$0.0	$0.0	$78.8	$82.0	$85.2	$88.7	$92.2	$0.0	$0.0	$0.0	$0.0	$426.9
Operating & Capital Balance	($2.7)	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1	$1.1	($2.0)	($5.3)	($8.8)	($11.5)	

Exhibit 3-4

Summary Of SEPTA Current And Projected Cash Flow With Regional Rail Alternative

Current $ Million

Fiscal Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Operating Revenue													
Farebox Revenue	$253.6	$264.5	$272.0	$282.9	$294.2	$306.0	$318.2	$330.9	$344.2	$357.9	$372.3	$387.3	$3,784.0
New Operation Revenue	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$14.1	$14.6	$15.2	$15.8	$59.7
Other Operating Revenue	57.2	58.4	60.7	63.2	65.7	68.3	71.1	73.9	76.9	79.9	83.1	$86.4	$844.8
Total Operating Revenue	$310.8	$322.9	$332.7	$346.1	$359.9	$374.3	$389.3	$404.8	$435.2	$452.4	$470.6	$489.5	$4,688.5
Non-Operating Revenue													
Federal Subsidy	$27.2	$27.2	$28.3	$29.4	$30.6	$31.8	$33.1	$35.1	$36.5	$37.9	$39.4	$41.7	$398.2
State Subsidy	$163.1	$166.5	$180.6	$186.4	$195.2	$204.2	$213.6	$223.4	$232.9	$242.2	$251.9	$262.0	$2,522.0
Local Subsidy	$55.7	$55.5	$60.2	$62.1	$65.1	$68.2	$71.2	$74.5	$77.6	$80.7	$83.9	$87.2	$841.9
State/Local Asset Maint.	$31.2	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$41.6	$42.6	$44.3	$46.1	$47.9	$503.2
Other Income	10.8	13.6	14.0	14.7	15.3	15.8	16.4	17.2	17.7	18.6	19.3	$20.0	$193.4
Total Non-Operating Revenue	$288.0	$304.4	$324.7	$334.2	$347.8	$361.6	$375.9	$391.8	$407.3	$423.7	$440.6	$458.8	$4,458.7
Total Revenue	$598.8	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$796.6	$842.5	$876.1	$911.2	$948.3	$9,147.2
Operating & Maintenance Expenses													
Labor & Fringe	$434.2	$434.5	$460.5	$479.0	$498.1	$518.1	$538.8	$560.3	$582.7	$606.0	$630.3	$655.6	$6,398.1
Materials & Service	$98.7	$101.8	$105.9	$110.1	$114.5	$119.1	$123.8	$128.8	$133.9	$139.3	$144.9	$150.7	$1,471.5
Injuries & Damage	$40.0	$38.0	$36.0	$34.0	$35.4	$36.8	$38.2	$39.8	$41.4	$43.0	$44.7	$46.5	$473.8
Propulsion Power	$25.2	$26.9	$27.9	$29.1	$30.2	$31.4	$32.7	$34.0	$35.4	$36.8	$38.2	$39.7	$387.5
Fuel	$9.7	$9.6	$10.0	$10.4	$10.8	$11.3	$11.7	$12.2	$12.7	$13.2	$13.7	$14.3	$139.7
Other Operating	($6.3)	$16.4	$17.1	$17.7	$18.5	$19.2	$20.0	$20.8	$21.6	$22.5	$23.4	$24.4	$215.4
Total Operating Expense	$601.5	$627.3	$657.4	$680.3	$707.7	$735.9	$765.2	$795.9	$827.7	$860.8	$895.3	$931.1	$9,086.1
Regional Rail Alternative	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$28.6	$29.7	$30.9	$32.2	$121.5
Balance From Operations	($2.7)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.7	($13.8)	($14.4)	($15.1)	($15.0)	($60.3)
Revenue Available For Capital													
Section 3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Flexible Funding	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Section 9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total Federal	$0.0	$0.0	$0.0	$70.8	$73.7	$76.6	$79.7	$82.9	$0.0	$0.0	$0.0	$0.0	$383.6
Local / State	$0.0	$0.0	$0.0	$17.7	$18.4	$19.2	$19.9	$20.7	$0.0	$0.0	$0.0	$0.0	$95.9
Total Capital Revenue	$0.0	$0.0	$0.0	$88.5	$92.1	$95.8	$99.6	$103.6	$0.0	$0.0	$0.0	$0.0	$479.6
Capital Expenditures													
Regional Rail	$0.0	$0.0	$0.0	$88.5	$92.1	$95.8	$99.6	$103.6	$0.0	$0.0	$0.0	$0.0	$479.6
Subtotal For Rail System	$0.0	$0.0	$0.0	$88.5	$92.1	$95.8	$99.6	$103.6	$0.0	$0.0	$0.0	$0.0	$479.6
Operating & Capital Balance	($2.7)	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1	$0.8	($13.1)	($27.5)	($42.6)	($57.6)	

APPENDIX 4

TECHNICAL ADVISORY COMMITTEE

TECHNICAL ADVISORY COMMITTEE

Name	Organization
Leo Bagley	Montgomery County Planning Commission Montgomery County Courthouse Airy & Swede Streets, Suite 201 Norristown, PA 19404 (610) 278-3746
Richard Bickel	Southeastern Pennsylvania Transportation Authority 841 Chestnut Street, 11th Floor Philadelphia, PA 19107 (215) 580-7238
Tom Cain	Southeastern Pennsylvania Transportation Authority SEPTA Suburban Transit Division 69th Street Terminal Upper Darby, PA 19048 (215) 580-5860
Jack Claffey	Delaware Valley Regional Planning Commission Bourse Building 21 S. 5th Street Philadelphia, PA 19106 (215) 592-1800
Wayne Clapp	Chester County Planning Commission Government Services Center, Suite 270 601 Westtown Road West Chester, PA 19382-4537 (610) 344-6285
Donald Cleary	Southeastern Pennsylvania Transportation Authority Railroad Division 714 Market Street Philadelphia, PA 19106 (215) 580-5818
Hal Davidow	Southeastern Pennsylvania Transportation Authority 841 Chestnut Street, 11th Floor Philadelphia, PA 19107 (215) 580-7960
Robert Hannigan	Pennsylvania Department of Transportation 917 Transportation Building Harrisburg, PA 17120 (717) 787-2358

Kim Heinle	Southeastern Pennsylvania Transportation Authority 714 Market Street, 4th Floor Philadelphia, PA 19106-2385 (215) 580-7073
Jerry Kane	Southeastern Pennsylvania Transportation Authority 841 Chestnut Street, 11th Floor Philadelphia, PA 19107 (215) 580-7151
Andrew Lenton	Philadelphia City Planning Commission 1515 Market Street, 17th Floor Philadelphia, PA 19102 (215) 686-4629
Arthur Loeben	Montgomery County Planning Commission Montgomery County Courthouse Airy & Swede Streets, Suite 201 Norristown, PA 19404 (610) 278-3722
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Robert Moore	Bucks County Planning Commission Administration Building, 5th Floor Main & Court Streets Doylestown, PA 18901 (215) 345-3402
John Pickett	Delaware County Planning Commission Toal Building, 2nd Floor 2nd & Orange Streets Media, PA 19063 (610) 891-5200
Linda Tedeschi	Southeastern Pennsylvania Transportation Authority 1515 Market Street, Suite 600 Philadelphia, PA 19102 (215) 580-5777
Thabet Zakaria	Delaware Valley Regional Planning Commission Bourse Building, 8th Floor 21 S. 5th Street Philadelphia, PA 19106 (215) 592-1800

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John Mason	Manuel Padron Associates 1175 Peachtree Street, Suite 414 Atlanta, GA 30361 (404) 873-3206
Donald Schneck	Booz Allen & Hamilton, Inc. 1700 Market Street, 17th Floor Philadelphia, PA 19103 (215) 496-8403
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